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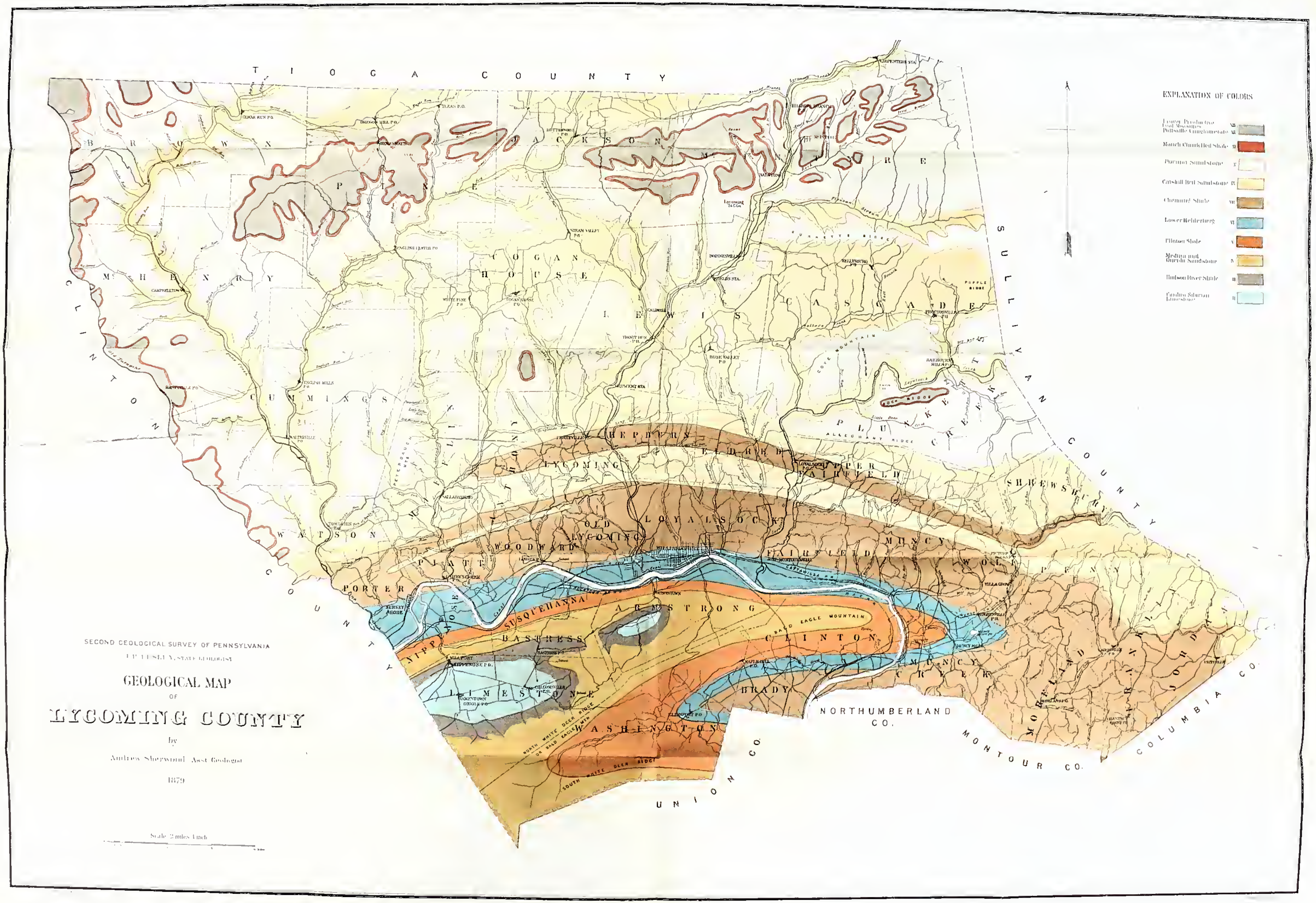

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA

J. P. LESLEY, STATE GEOLOGIST

GEOLOGICAL MAP
OF
LYCOMING COUNTY

by

Andrew Sherwood Asst. Geologist

1879

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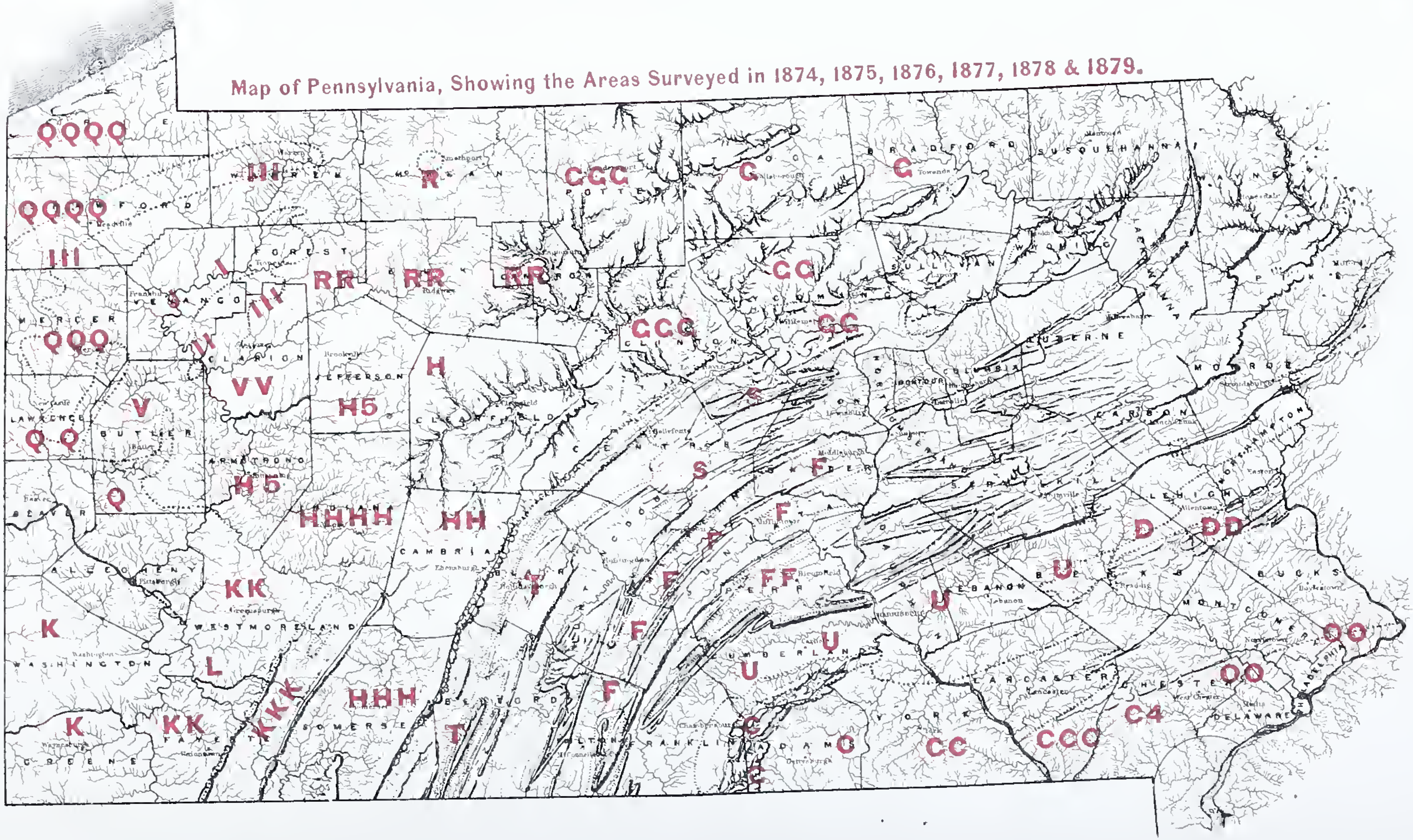
Map of Pennsylvania, Showing the Areas Surveyed in 1874, 1875, 1876, 1877, 1878 & 1879.



SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA:

REPORT OF PROGRESS.

GG.

THE GEOLOGY OF LYCOMING AND SULLIVAN COUNTIES.

1. Field Notes by Andrew Sherwood.
2. Coal Basins by Franklin Platt.

WITH TWO COLORED GEOLOGICAL COUNTY MAPS,
AND NUMEROUS ILLUSTRATIONS.

HARRISBURG:
PUBLISHED BY THE BOARD OF COMMISSIONERS
FOR THE SECOND GEOLOGICAL SURVEY.
1880.

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PHILADELPHIA, *January 1, 1880.*

To his Excellency GOV. HENRY M. HOYT, *Chairman of the Honorable Board of Commissioners of the Second Geological Survey of Pennsylvania:*

SIR: I have the honor to present a report of progress of the survey in the counties of Lycoming and Sullivan, begun by Mr. Andrew Sherwood in 1877, and continued by Mr. Franklin Platt with special reference to the coal measures in 1878–9.

Geological colored maps of the two counties accompany the text, which is illustrated by a sufficient number of vertical sections to make plain the geology. The country is still in large part a wilderness, and many curious items of geology remain no doubt to be discovered; but the important facts are fully and clearly stated. It would be very desirable to have the triangulation of the State extended to this region, and an accurate topographical survey of it made.

I remain, sir,
Your obedient servant,
J. P. LESLEY.

MANSFIELD, *March 1, 1878.*

Prof. J. P. LESLEY, *State Geologist:*

SIR: I have the honor to submit the following notes of observations made in the county of Lycoming while tracing the outcrop in the summer of 1877.

But I wish more particularly to call your attention to the accompanying maps, the construction of which was the great object we had in view.

I have the honor to remain,
Your obedient servant,
ANDREW SHERWOOD.

615 Walnut Street,
Philadelphia, *July 31, 1879.*

Prof. J. P. Lesley, *State Geologist:*

Dear Sir: In accordance with your instructions, I have examined the coal basins of Lycoming county and submit the following report thereupon.

The survey has been materially assisted in the gathering of facts relating to these basins by Mr. E. H. Burlingame, of Williamsport, Mr. Geo. H. Platt, chief engineer of the McIntyre Coal Company, by Mr. Chas. S. Green, of the Red Run Coal Company, and others.

I remain,
Your obedient servant,
Franklin Platt,
Assistant Geologist.

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REPORT OF THE PROGRESS

OF THE

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA,

IN

LYCOMING COUNTY.

CHAPTER I.*

General description of the County.

§ 1. Lycoming county belongs to the second tier of counties south of the New York State line, and about midway between the eastern and western limits of the State. It is in a general way conterminous to the south with Tioga County—the Tioga County line forming the whole of the north line of Lycoming County (a distance of 42½ miles), except the two and a half miles at the eastern end, which forms part of the south line of Bradford. This northern line of Lycoming crosses Pine Creek a mile and a half below Lloyd Post-office, and at the mouth of Babb's Fork; crosses the headwaters of the first fork of Pine Creek about two miles north of Opossum Run (Texas Post-office); strikes Lycoming Creek at the mouth of Roaring Branch Post-office, and ascends Lycoming Creek to the Bradford County corner.

The eastern border of Lycoming County runs south-east

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*Field notes of Andrew Sherwood, Assistant Geologist, edited by J. P. Lesley.

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about 14 miles to the Loyalsock Creek, 4 miles above Barbour's Mill Post-office; thence about 10 miles south-east to Muncy Creek, a mile and a half below Muncy Bottom; thence south-east about 7 miles to the Columbia County line; thence south-west 10 miles to the southeast corner.

The southern line of the county is very irregular; at first, nearly west to the Susquehanna River—a distance, in a straight line, of 16 miles at Montgomery Station Post-office, 6 miles below Muncy; thence north-west 4 miles to the top of the Bald Eagle Mountain; thence south-west 7 miles to the top of the White Deer Mountain; thence irregularly south-west 8½ miles to the gap of White Deer Creek (North Branch). This may be considered the southwest corner of the county.

The western line of the county is straight north-west 10½ miles to the mouth of Pine Creek on the Susquehanna River; thence, in the same direction, up Pine Creek four miles and a half; and thence, in very nearly the same direction, by following the Jersey Shore and Coudersport Turnpike, nearly 30 miles to the Potter County line; thence north two miles and a half, along the eastern line of Potter County to the Tioga County corner.

§ 2. The townships in Lycoming County are ranged according to the following order:

BROWN. PINE. JACKSON. McINTYRE.
HENRY.
COGAN-HOUSE. LEWIS. CASCADE.
CUMMINGS. PLUNKETT'S CR. SHREWSBURY.
Mifflin. Anthony. Lycoming. Hepburn. Eldred. U. Fairfield.
— Old Muncy. Wolf. Penn.
Woodward. Lycoming. Loyalsock. Fairfield.
WATSON. PLATT. JORDAN.
Susquehanna Muncy
Bastress. ARMSTRONG. CLINTON. Creek. Moreland.
LIMESTONE. WASHINGTON.

§ 3. The area of Lycoming County is given in Gray & Walling's Atlas at 1,080 square miles, or 691,200 acres, containing in 1860, 37,399 persons, and in 1870, 47,626. Williamsport, its county seat, was laid out in 1796.

§ 4. The county is divided into three parts by its geological structure and the geographical aspect of its surface.

The northern half of the county is an elevated mountain plateau, the southern edge of which is called the Allegheny Mountain; and this corresponds, both geologically and topographically, with the country (already described) to the north of it in Tioga and Potter Counties, and to the country next to be described in Sullivan and Wyoming. Its general surface lies about 2,000 feet above the sea; is covered with broken rock belonging to the Pocono sandstone and conglomerate; and with a dense forest (formerly of pine), now much cut off.

The middle belt of the county is a sweeping curve of Devonian rock, forming the broad valley of the North Branch Susquehanna from Jersey Shore past Williamsport to Muncy, where it broadens out into the open country of Columbia County, Montour and Northumberland. In the middle belt, which is about 5 miles wide, and along the southern edge of the belt flows the West Branch of the Susquehanna River, with the West Branch Canal and the Philadelphia and Erie R. R.

The southern division of the county is a mass of mountain land composed of Silurian sandstones, including valleys of Silurian limestone divisible into three parts—the northern being the mass of the Bald Eagle Mountain, and the southern the mass of the White Deer Range. Between these two penetrate westward across the Susquehanna a triangular plain of the Devonian Northumberland and Montour Counties before mentioned. This disvision is being surveyed in detail hypsometrically, by Mr. Charles E. Billin, and will be reported upon by him.

§ 4. The middle belt is again divisible into two parts—the southern and northern, or the belt in which the river flows along the northern foot of the Bald Eagle Mountain in rocks of the Clinton No. 5, Lower Helderberg Limestone No. 6, Oriskany Sandstone No. 7, Upper Helderberg Limestone Hamilton Slates and Sandstones and Portage Gray Sandstones No. 8, with the lower part of the Chemung formation traversed lengthwise by parallel, steeply inclined anticlinal and synclinal folds.

The northern part of this middle belt consists of alternate belts—anticlinal and synclinal,—of Chemung and Catskill rocks along the southern base and rising upon the slope of the Allegheny Mountain.

The southern half of this middle belt is included in this report: the northern half has been surveyed by Mr. Sherwood, and is also included in this report, together with the mountain plateau occupying the northern division of the county.

§ 5. The drainage of Lycoming County is entirely from the north, southward, that is,—from the mountains of Tioga, Bradford and Potter into the Susquehanna West Branch by means of the various branches of Pine Creek, at the western side of the county; by the branches of Lycoming Creek through its center; and by Loyalsock and Muncy Creeks in the east and southeast.

All these waters descend through the heart of the mountain plateau in gorges which are veritable cañons, exceedingly tortuous and narrow, with bottoms scarcely wider than the meanderings of the streams, and with side slopes of excessive steepness, crowned with cliffs of sandstone and conglomerate, forming a cornice about a thousand feet above the water-bed. Innumerable ravines descend from the table-lands between the streams and their branches, cutting sharply down to the water-beds, rendering a geographical description of the county impossible, except by reference to the colored map which accompanies the report.

The colored map will show, without further explanation, how the table-land is broken up into a multitude of isolated patches or tablets between the streams, and will show the shape and extent of these. It will show also that in spite of the apparent irregularity of their distribution, they range themselves in well-defined belts across the country, in a direction about north 30 east, south 30 west. These belts sometimes coalesce, and this phenomenon must always be taken, when it occurs, as an indication of the gradual decline of the anticlinals, permitting the Pocono rocks (with the overlying plate of conglomerate, and sometimes with patches of the lower coal measures), to spread north and south from belt to belt. A further description of the structure must be left to the detailed account of the townships.

§ 6. A marked phenomenon, however, must here be noted. The south wall of the Allegheny Mountain (overlooking the valley of the West Branch), although broken by ravines in many places, appears to the eye of the spectator as a continuous wall from the head of Muncy Creek to the gorge of the Susquehanna, at Lockhaven; and theoretically it may be considered as continuous from the head of Muncy Creek westward to Pine Creek; but at Pine Creek it has advanced two or three miles southward into the valley, and continues thence to run in this advanced line to Dunsburgh, on the Susquehanna, and so to Altoona in Blair county. This jog in the mountain wall is produced by a narrow synclinal, in which lies (west of the Susquehanna), the Tangascootac coal basin and (east of the Susquehanna) Queen's Run continuation of the same. East of the head of Queen's Run the coal is eroded, and then the conglomerate with its red shale under it, leaving the Pocono to form a terminal Knob opposite Jersey Shore. Behind this Knob is an anticlinal cove of Catskill rocks, in which flows Pond's Run. The Knob in front of it is called Short Mountain; and in front of Short Mountain flows Nickel's Run, McKinney's Run (both in Porter Township), and Canoe Run in Mifflin Township. The valleys of these brooks are the base of the mountain.

§ 7. The Short Mountain synclinal continues from the end of Short Mountain, north 15 east, as a belt of Catskill rocks two miles wide, to Lycoming Creek; and in it flows Beaudy's Run, a mile south of Hebron. Thence it continues due east to Loyalsock Creek, and thence through Fairfield village to Muncy Creek at Pictured Rocks Post-office, bending a little south; thence it continues east to the extreme eastern corner of the county.

§ 8. The Tomb's Run anticlinal, behind Short Mountain, runs north 15 east through Saladasburg to Cogan Station Post-office, on the Lycoming; through Warrenville on west Mill Creek; through Loyalsock village on Loyalsock; and through Tivoli Post-office, on Muncy Creek; and then appears to lose itself in the flat dips of Franklin and Jordan Townships, at the east end of the county.

It will be seen by the detailed township reports that this anticlinal brings up Chemung rocks to the foot of the mountain, along about 25 miles of its course, in a belt about two miles wide—the Chemung rocks making their appearance from beneath the Catskill about a mile east of Saladasburg, and still continuing to show themselves for three miles up Muncy Creek above Tivoli Post-office.

§ 9. Returning to the front of Short Mountain, a sharp synclinal of Catskill back of Jersey Shore, a mile and a half east of Pine Creek, runs in a straight line, north 20° east, about 9 miles, to the head of Bottle Run, in old Lycoming Township. The synclinal trough continues much further than this belt of Catskill rocks, both to the west and to the east of its terminations, but in Chemung rocks.

§ 9. Other anticlinals and synclinals will be mentioned to the south of the Short Mountain synclinal, but need not here be noticed.

§ 10. Important structural phenomena show themselves in Lycoming County ;—affecting, in fact, the structure of the whole middle part of Pennsylvania ; and these can only be well understood by an examination of a colored map of the State. It may be said here, however, in a general way, that the presence of numerous parallel, steep, closely plicated anticlinals and synclinals between Muncy and Jersey Shore east and west, and between the north flank of the Bald Eagle Mountain, with its vertical dips, and the south face of the Allegheny Mountain (eight miles distant to the north of it) show a movement of the whole of middle Pennsylvania northward against the great table-land of northern Pennsylvania, the rocks of which are everywhere almost horizontal. All the folding produced by this movement seems to have been taken up in the narrow belt of eight miles, as if the inertia of the northern counties stopped it at the face of the Allegheny mountain. This movement is part, and in fact may be considered as the end, of a general movement of the whole country between the Susquehanna River at Williamsport, Lockhaven and Altoona, and the

South Mountains in Cumberland and York Counties. It seems to have had its origin in a cause involving the rise of the South Mountains;—consequently the geology of the central region of Pennsylvania is characterized by an extraordinary number of closely packed anticlinal and synclinal folds, some of them of great magnitude and others very small: whereas, the geology of the eastern region of Pennsylvania, occupied by anthracite coal basins, is characterized by a comparatively few, but very large, anticlinals and synclinals terminating against the north or Allegheny Mountain in Sullivan and Wyoming Counties without any such exhibition of a crushed, folded structure as that which we have described in Lycoming County.

§ 11. This distinction between the regions of central and eastern Pennsylvania is one vital to the explanation of the drainage of the State;—for in the central region almost all the areas of the surface are occupied by the older Silurian rocks: while in the other or eastern region, most of the areas are occupied by the Devonian and later carboniferous formations. This of itself would show that there has been a greater amount of push northward, and plication, in the central region than in the eastern region.

The salient feature of the map which indicates the distinction between the two regions, is the valley of the Susquehanna and its West Branch;—for this distinctly separates the central from the eastern region, and the same explanation must be given of the course of the river—first eastward through the Williamsport valley round the end of the Bald Eagle Mountain at Muncy, and then southward to Harrisburg, which is given for the presence of the anthracite coal basins (wholly to the east of the river); in fact, the Susquehanna shows that it has sought a course everywhere as much as possible confined to the soft rocks at the top of the Silurian and bottom of the Devonian systems.

§ 12. The second feature which must be noted is presented by the drainage of the North Branch of the Susquehanna in northeastern Pennsylvania. Naturally, when the Susquehanna river enters Pennsylvania from the State of New York, it might have been expected on reaching the neighborhood of Towanda in Bradford County instead of bending southeast and cutting through the highlands of Wyoming County to turn west up the present valley of Towanda Creek across the low divide in southwestern Bradford and descend the present water-bed of the Lycoming. This would have been its shortest course to its destination, and nothing can be more remarkable than its long and apparently useless detour which the river makes by the way of Tunkhannock, Pittston, Wilkesbarre, Berwick, Bloomsburg and Danville to Northumberland. For such a detour, however—as for all the surface phenomena of the globe,—there must be a good, sound, geological explanation; and it is to be found in the statement (made above) of the complete difference between the geological structure of central Pennsylvania and eastern Pennsylvania, in the matter of plication. To this, however, must probably be added as part of the explanation a thickening of the rocks of the Upper Devonian in certain parts of the region which we are describing. This, however, must be quite subordinate to the other.

§ 13. A glance at the map will show that the direction of the anticlinals and synclinals of middle Pennsylvania is approximately northeast and southwest; and this northeast-southwest direction is seen to be preserved by the anticlinals and synclinals of western Lycoming, Cameron, Tioga, Potter and McKean.

But, on following all or any of these anticlinals and synclinals eastward to the Susquehanna River, or to the line of the Lycoming Creek and the Tioga River, they will be found taking gradually and sometimes rapidly a direction not from southwest to northeast but from west to east;—in other words, sweeping round in curves into the region of northeastern and eastern Pennsylvania.

But again, after passing the Susquehanna, Lycoming and Tioga, and pursuing this east course for 20 or 30 miles, they are seen to change once more their direction in grand curves toward the northeast, and finally sweeping out with that direction at the northeast corner of the State. This is especially to be observed in the country east and north of Wilkesbarre;—for from Wilkesbarre to Carbondale the course of all the anticlinals and synclinals is again southwest-northeast and on reaching Carbondale the direction becomes about north 10 or 15 east.

The crush of the northward movement of the central region of the State against the Allegheny mountain-face in Lycoming County, produces the belt of closely folded anticlinals and synclinals in the Williamsport valley running east and west. Against this crush comes down, from the northeast, the system of broad, flattish anticlinals and synclinals of Susquehanna, Wyoming and Sullivan Counties; and it is just back of the crush—that is, to the north and to the northeast, especially in eastern Lycoming and in Sullivan County,—that the Allegheny table-land has one of its widest expansions. Through this table-land pass the flat anticlinals and synclinals.

§ 14. It is impossible, without an excessively minute, instrumental, hypsometrical survey of this forest-covered mountain region—at great expense of time and money, that any precise determination can be made of the method by which the broad anticlinals and synclinals of the North Branch of the Susquehanna terminate in, or merge with, the short, sharp anticlinals and synclinals in face of the mountain at Williamsport. All that can be said now is this: namely, that the synclinal of eastern Susquehanna County, holding the Elk Mountain peaks in Gibson Township, sweeps across the North Branch below Tunkhannock and holds the Mahoopany Mountain plateau in Wyoming County, and then descends Muncy Creek, south of Laporte, to Tivoli Post-office, where it seems to merge into the east end of the Tomb's Run or Cogan Station anticlinal of Lycoming County.

§ 15. In like manner the Tunkhannock synclinal, with its Bernice coal basin, keeps down the valley of Plunkett's Creek and holds the patches of Pocono sandstone mountain tops between the Loyalsock and the Lycoming, which are in view from Williamsport. This is James D. Hodge's "first trough" as described in the Final Report of 1858; but he supposed that it was the same as the Queen's Run and Tangascootac coal basin trough: whereas, it has been shown above that it is the next synclinal to the north.

§ 16. Next in order (north) comes the Wilmot anticlinal, crossing the North Branch of Susquehanna at Laceyville, and making a wide Chemung valley south of New Lancaster to Campbellsville in Sullivan County, bordered on each side by belts of Chemung lowland. This anticlinal, passing under a bridge of Pocono at the west end of Sullivan County, comes out again in Catskill rocks through northern Cascade Township in Lycoming County around Kellyburg Post-office, and holds the waters of Salt Run, Roaring Run and Wallace Run.

§ 17. North of this is the synclinal of the Barclay coal basin, in Bradford County, which passes southwest as a broad mountain plateau with patches of coal through MacIntyre Township, Lycoming County, east and west of Ralston, and is continued southwest as the mountain plateau west of Lycoming Creek, cut into pieces by Gray's Run, Hogeman's Run, Trout Run, Hogland Run, Larry's Creek and the first and second forks,—and then Pine Creek.

§ 18. It thus appears that Hodge's first and second basins, (with the Bernice coal and the Barclay coal) close up, perhaps merge together, on Pine Creek near the mouth of the first fork, and so continue southwestward across the West Branch of the Susquehanna above Queen's Run, forming the second basin of Cameron County. This is the nearest approach which we can now make to an identification of the coal basins, or rather of the great synclinal troughs, east and west of the central line of disturbance which may be considered as traversing north and south through Lycoming County.

I do not consider that an accurate identification is of any practical value, but its theoretical interest to the geologist is very great; and if it could be made out completely, it would assist us in our search for the best situations in which to seek the small and isolated patches of the lowest coal bed left on the summits of the table mountains in this part of Lycoming County.

Topography of the County.

§ 19. Along the north side of the Susquehanna and extending back from the river for a distance of from six to eight miles, the surface is rolling and hilly, excepting of course the river plain, which is comparatively level and from one to two miles in width. The whole of this broad belt of from six to eight miles may be called the Williamsport Valley.

Over the remainder of the county, lying north of this valley, the surface is mountainous, except in the two *anticlinal valleys* of *Rose Valley* and *Cogán House.*

§ 20. The plateau of the Allegheny Mountain is here from fourteen to twenty miles or more in width. It is furrowed in every direction with deep gorges and cañons, two of which, Pine Creek and Lycoming Creek, are cut entirely across it. Both its north and south escarpments rise to a pretty uniform height of several hundred feet above the rolling hill country spread out on either side.

Its northern acclivity runs from the corner of Bradford County, along the south side of Lycoming Creek and Roaring Branch, crossing the Blockhouse fork of Little Pine Creek at Buttonwood P. O., where it begins to round off to the north, as far as the edge of Tioga County, when it again turns to the southwest, running past Texas P. O. to Oregon Hill P. O., where it rounds off into Tioga County, and unites with the Blossburg range of mountains.

Its southern acclivity enters Lycoming County from Sullivan County a little north of Muncy Creek; runs along the south side of Plunkett's Creek and Lewis townships to Crescent Station, on Lycoming Creek, thence to the northeast corner of Watston township, thence to Tomb's Run, on Pine Creek, where it turns and runs to the east, as far as Canoe Run, in Mifflin township, a distance of four miles, at which point it rounds off and returns to the southwest, crossing Pine Creek near where the old Jersey Shore and Coudersport turnpike crosses.

Geological Structure of the County.

§ 21. This mountain region is traversed, as described in general terms above, by a series of anticlinals and synclinals, having a general direction of northeast and southwest.

§ 22. The *Blossburg synclinal* crosses the northwest corner of the county. It probably contains coal.

§ 23. The *Towanda anticlinal* lies about four miles to the southeast of the Blossburg axis, entering the county at the southwest corner of Brown township, and leaving it where Little Pine Creek crosses the county line. It is here a very flat arch, there being none of the steep dips met with along the same axis further to the northeast. The long anticlinal valley which accompanies it from the North Branch of the Susquehanna River, in Bradford County, heads up at Oregon Hill P. O., in Pine township.

§ 24. The *Barclay and McIntyre synclinal* comes up from the southwest, out of Clinton County, crosses Pine Creek about one and a half miles above Campbelltown; runs through the central part of Pine township; through the south part of Jackson township; through the central part of McIntyre township; crosses Little Pine Creek about one and a half miles above the mouth of the Blockhouse Fork; crosses the Blockhouse Fork about one mile below Buttonwood P. O.; crosses the Lycoming Creek near the mouth of Dutchman's Run, at McIntyre; and leaves Lycoming County about three fourths of a mile south from the corner of Sullivan County. In Pine, McHenry and McIntyre townships it holds valuable beds of coal; also at Barclay in Bradford County. The same axis can be traced, though in diminished force, across Bradford and Susquehanna Counties, past Wyalusing, Montrose and Great Bend.

§ 25. The *Cogan House* and *Jersey Mills anticlinal* enters Lycoming County from Clinton County a little north of Haneyville P. O.; crosses Pine Creek about one mile above Jersey Mills P. O.; crosses Little Pine Creek near the mouth of Carson Run; thence on past White Pine P. O., and Cogan House P. O., terminating in the southwest corner of McIntyre township. In Cogan House township it is accompanied by an anticlinal valley from two to three miles in width, and about twelve miles in length, with surface rocks of the Red Catskill group. This valley heads up at both ends in a broad amphitheatre, one at the northeast end of Cummings' township, and the other in the southwest corner of McIntyre township. In this remarkable valley several streams take their rise, flowing towards and into the mountains.

§ 26. The *Rose Valley anticlinal* runs from Rose Valley P. O., in Lewis township, to the Sullivan County line in the northeast corner of Plunkett's Creek township, passing a little to the south of Kellysburg. The axis throughout this distance (about sixteen miles) traverses an anticlinal valley, from three to four miles in width, having the Red Catskill for the surface rock, and heading up at both ends in a broad amphitheatre, one a little west from Rose Valley, and the other just at or within the edge of Sullivan County.

§ 27. The *Waterville, Loyalsock and Bernice synclinal* comes from the southwest, out of Clinton County; crosses Pine Creek about one mile above Waterville; crosses Lowry's Creek near the northeast corner of Mifflin township; crosses Lycoming Creek about half a mile above Crescent Station; crosses Wallace Run about half a mile above its mouth; and leaves Lycoming County to enter Sullivan County where the Loyalsock Creek crosses the county line. The smaller amount of coal which this basin seems to contain, compared with the McIntyre Basin, is possibly owing in part to a greater thickness of the Level Conglomerate of XII. Further east, in Sullivan County it holds the Bernice Coal field.

§ 28. The *Tomb's Run and Muncy Creek anticlinal* runs from Tomb's Run, on Pine Creek, past Salladasburg to Cogan Station or Lycoming Creek; thence past Loyalsock P. O. on the Loyalsock, and Tivoli P. O. on Muncy Creek; leaving Lycoming County to enter Sullivan County where Muncy Creek crosses the county line.

§ 29. The *Short Mountain, Hepburn* and *North Mountain synclinal* runs from Pine Creek, in the south part of

Watson township, to Hepburn on the Lycoming Creek; thence to Picture rocks on Muncy Creek; and leaves Lycoming County at the north corner of Franklin township. In Watson township it receives Short Mountain, while on the edge of Sullivan County it receives the North Mountain.

Four vertical sections, by Mr. Sherwood.

§ 30. The following detailed sections of the measures underlying the Pottsville Conglomerate, XII, were made by Mr. Sherwood, at four widely separated places in Lycoming County, and are here grouped together for ready comparison.

Section 1, Fig. 1, 1007 feet of north dipping rocks, on Cedar Creek in Brown township reads as follows, from above downwards:

48.	POTTSVILLE CONGLOMERATE, coarse white sandstone at the top of the mountain, where it covers about 1000 acres in a nearly continuous mass, but separated in places by deep fissures,		70′
47.	Sandstone, dark colored, turning into a black sandy shale at the top, with signs of *Coal*,	MAUCH CHUNK	20′
46.	Shale, soft, light colored, with signs of iron ore,		30′
45.	Sandstone, thin bedded, gray,		10′
44.	Sandstone, coarse, gritty, light colored,		25′
43.	*Interval concealed*,		30′
42.	Shale, red and greenish, mottled,		5′
41.	Sandstone, reddish,		10′
40.	Shale, red, marly,		35′
39.	Shaly sandstone, greenish,		8′
38.	Sandstone, false bedded, gray,		10′
37.	Shale, red, marly,		15′
36.	Sandstone, reddish and greenish,		33′
35.	Shale, red, marly,		20′
34.	Sandstone, reddish. [Bottom of XI?]		20′
33.	Sandstone, fine grained, greenish,	POCONO	12′
32.	Gray band, with *plant stems and thin coal seams*,		4′
31.	Sandstone, gray, shaly,		10′
30.	*Interval concealed*,		20′
29.	Sandstone, false bedded, gray,		40′
28.	*Interval concealed*,		30′
27.	Sandstone, false bedded, gray,		30′
26.	Sandstone, reddish and greenish, shaly, thin bedded,		18′
25	Sandstone, false bedded, gray,		20′
24.	Shale, reddish,		10′
23.	Sandstone, false bedded, gray,		12′
22.	*Calcareous* rock resembling a breccia, gray,		12′

21.	Shale, reddish, sandy,		10′
20.	Sandstone, false bedded, gray,		30′
19.	*Interval concealed,*		23′
18.	Sandstone, thin bedded, diagonally laminated, gray,		39′
17.	Sandstone, reddish, thick bedded,		20′
16.	Sandstone, gray, shaly,		12′
15.	Sandstone, coarse, gray [Bottom of X?]		90′
14.	Sandstone, red, [Top of IX?]		34′
13.	*Interval concealed,*		25′
12.	Sandstone, gray,		15′
11.	Shale, red,		10′
10.	Shale, gray,		5′
9.	Sandstone, red,		5′
8.	Shale, red,	CATSKILL	20′
7.	Sandstone, red,		8′
6.	Shale, red, with streaks of green,		8′
5.	Shale, greenish,		4′
4.	Sandstone, gray,		20′
3.	Shale, red,		40′
2.	Sandstone, red,		20′
1.	Shale, red,		10′
	Total of exposure,		1037′

Section 2, Fig. 2, of 1039 feet of north dipping measures, on Rock Creek, in McIntyre township, reads as follows, from above downwards:

	Top of Mountain.		
35.	Sandstone, coarse, brownish [XII,]		60′
34.	Conglomerate and Sandstone, coarse white.		100′
33.	*Interval concealed,*		100′
32.	Shale, red,		20′
31.	*Interval concealed,*		20′
30.	Sandstone, false bedded, gray and greenish [XI?]		42′
29.	Sandstone, gray and reddish,	MAUCH CHUNK	12′
28.	Shales, red, marly and sandy,		24′
27.	Sandstone, reddish,		40′
26.	Shales, red, marly,		28′
25.	Sandstone, gray and reddish [Bottom of XI?]		25′
24.	*Interval concealed,*		20′
23.	Sandstone, thin bedded, gray,		14′
22.	Shale, reddish, sandy,		5′
21.	Sandstone, thin bedded, gray,		20′
20.	Sandstone, false bedded, coarse, gray,		33′
19.	Sandstone, shaly, gray,		15′
18.	Sandstone, shaly, reddish,		20′
17.	*Interval concealed,*		40′

16.	Sandstone, coarse, gray, with *plant stems*,	Pocono	34′
15.	Sandstone, reddish,		20′
14.	Sandstone, false bedded, gray,		35′
13.	*Interval concealed,*		15′
12.	Sandstone, thin bedded, gray,		10′
11.	*Interval concealed,*		15′
10.	Sandstone, shaly, reddish,		10′
9.	Sandstone, false bedded, gray,		27′
8.	Sandstone, false bedded, shaly, reddish,		20′
7.	Sandstone, false bedded, gray,		32′
6.	*Interval concealed,*		30′
5.	Sandstone, thick bedded, gray [bottom of X ?]		75′
4.	*Interval concealed,*		20′
3.	Sandstone, red,	Catskill	8′
2.	*Interval concealed,*		30′
1.	Shale, red,		10′
	Total,		1039′

Section 3, Fig. 3, of 1083 feet of north dipping measures, on Trout run in Lewis township reads as follows, from above downwards:

Top of the Mountain.

28.	Conglomerate,		60′
27.	*Interval concealed,*		65′
26.	Sandstone, coarse, brownish,	Mauch Chunk	30′
25.	Sandstone, thin bedded, greenish,		15′
24.	Shale, red and green,		10′
23.	Sandstone, reddish,		5′
22.	Shale, red, marly,		35′
21.	Sandstone, false bedded, reddish and greenish,		51′
20.	Shale, red,		30′
19.	Sandstone, reddish, [bottom of XI ?]		30′
18.	*Interval concealed,*		100′
17.	Sandstone, gray, some of it false bedded,	Pocono	60′
16.	Sandstone, thin bedded, gray and reddish,		37′
15.	*Interval concealed,*		100′
14.	Sandstone, false bedded, gray,		40′
13.	*Interval concealed,*		50′
12.	Sandstone, shaly, gray,		28′
11.	Sandstone, reddish,		20′
10.	*Interval concealed,*		57′
9.	Sandstone, false bedded, gray,		30′
8.	*Interval concealed,*		43′
7.	Sandstone, gray [bottom of X ?]		50′

6.	*Interval concealed,*	CATSKILL	50′
5.	Shale, red,		15′
4.	Sandstone, false bedded, gray,		18′
3.	Shale, red,		14′
2.	Sandstone, red,		20′
1.	Shale, red,		20′
	Total,		1083′

Section 4, Fig. 4, of 1204 feet of north dipping measures, on Loyalsock Creek, in Plunkett Creek township, reads as follows, from above downwards:

	Top of the Mountain.		
22.	Sandstone, brownish,		175′
21.	Conglomerate and Sandstone, coarse, white,	XII,	120′
20.	Slate, black and dark, traces of coal, roots of *Sigillaria* and *other plants*,	MAUCH CHUNK	25′
19.	*Interval concealed,*		150′
18.	Sandstone, reddish,		30′
17.	*Interval concealed,*		75′
16.	Shale, red, marly,		25′
15.	Sandstone, false bedded, reddish,		45′
14.	*Interval concealed,*		40′
13.	Sandstone, false bedded, reddish [bottom of XI ?]		25′
12.	*Interval concealed,*	POCONO	30′
11.	Sandstone, thin bedded, gray,		20′
10.	*Interval concealed,*		40′
9.	Sandstone, false bedded, coarse, gray, with *stems of plants*,		60′
8.	Shale, gray and Sandstone, shaly,		20′
7.	Sandstone, gray, with *plant stems*,		37′
6.	Sandstone, reddish,		25′
5.	*Interval concealed,*		45′
4.	Sandstone, false bedded, reddish,		27′
3.	Sandstone, false bedded, gray,		100′
2.	*Interval concealed,*		50′
1.	Sandstone, diagonally laminated, gray, at mouth of Plunkett's Creek, in the bed and banks of the Loyalsock Creek [Bottom of X ?]		40′
	Total,		1204′

Section of North dipping Rocks on Cedar Creek, Lycoming County.

Sec. 1. Fig. 1.

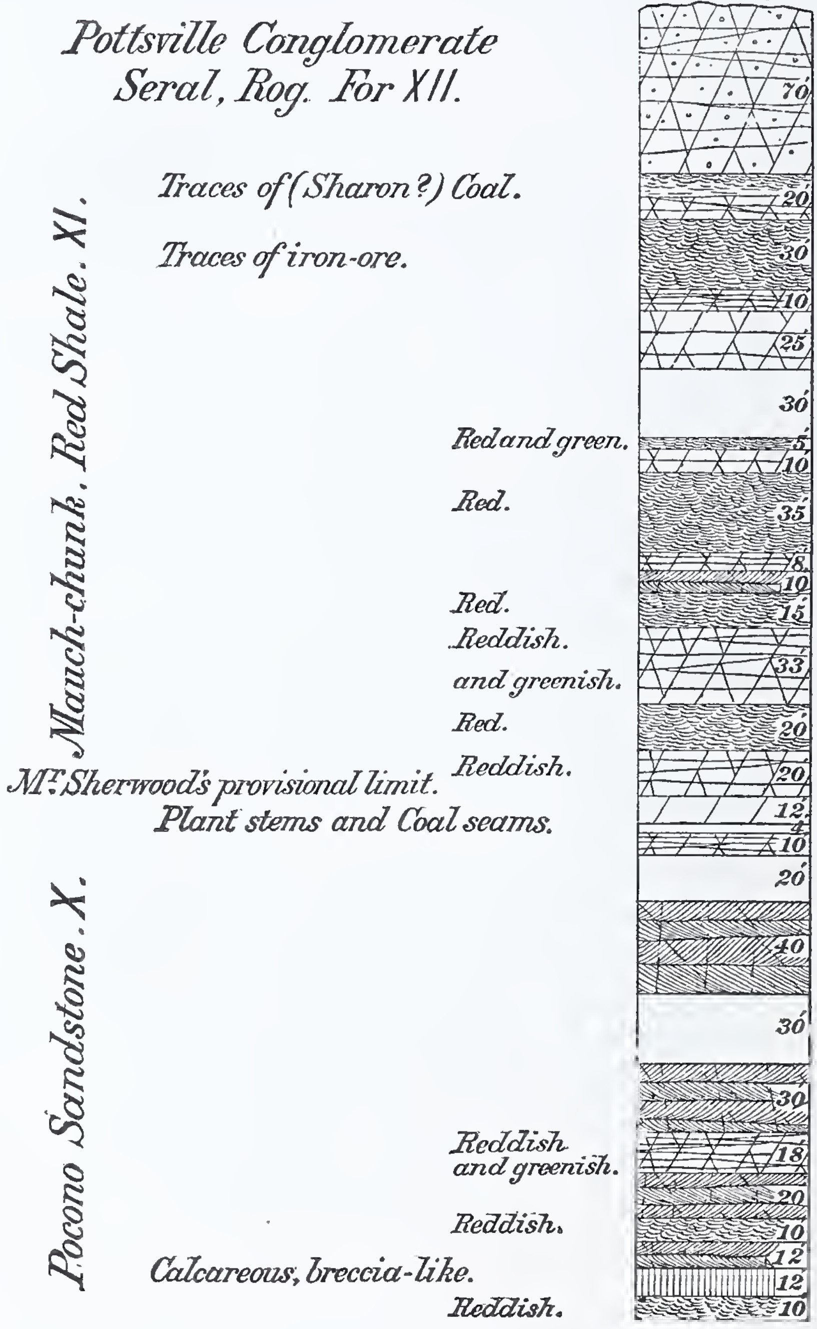
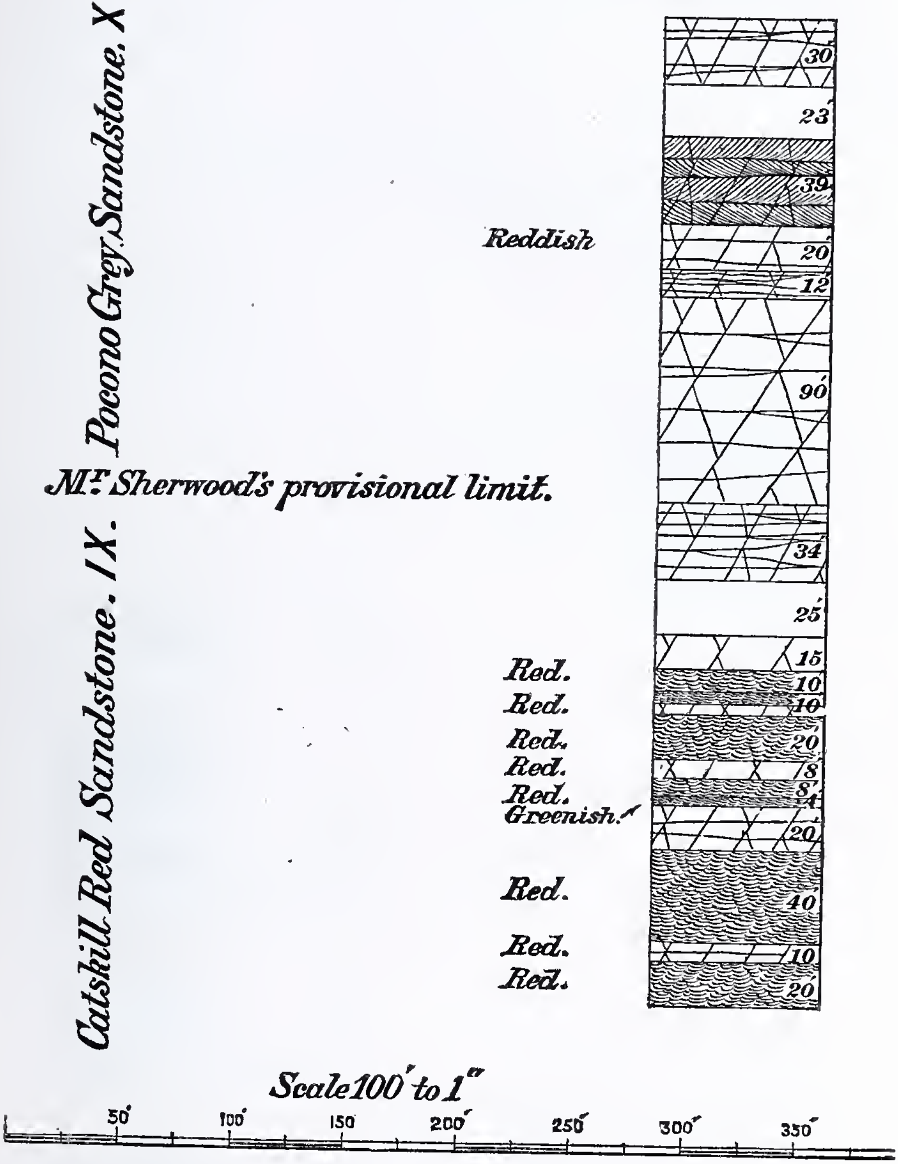


Fig. 1. continued.



Note. All the following long sections are thus drawn but the local short sections on the scale of 10′ : 1″.

Section of North dipping Rocks on Rock Creek, Lycoming County.

Sec. 2. Fig. 2.

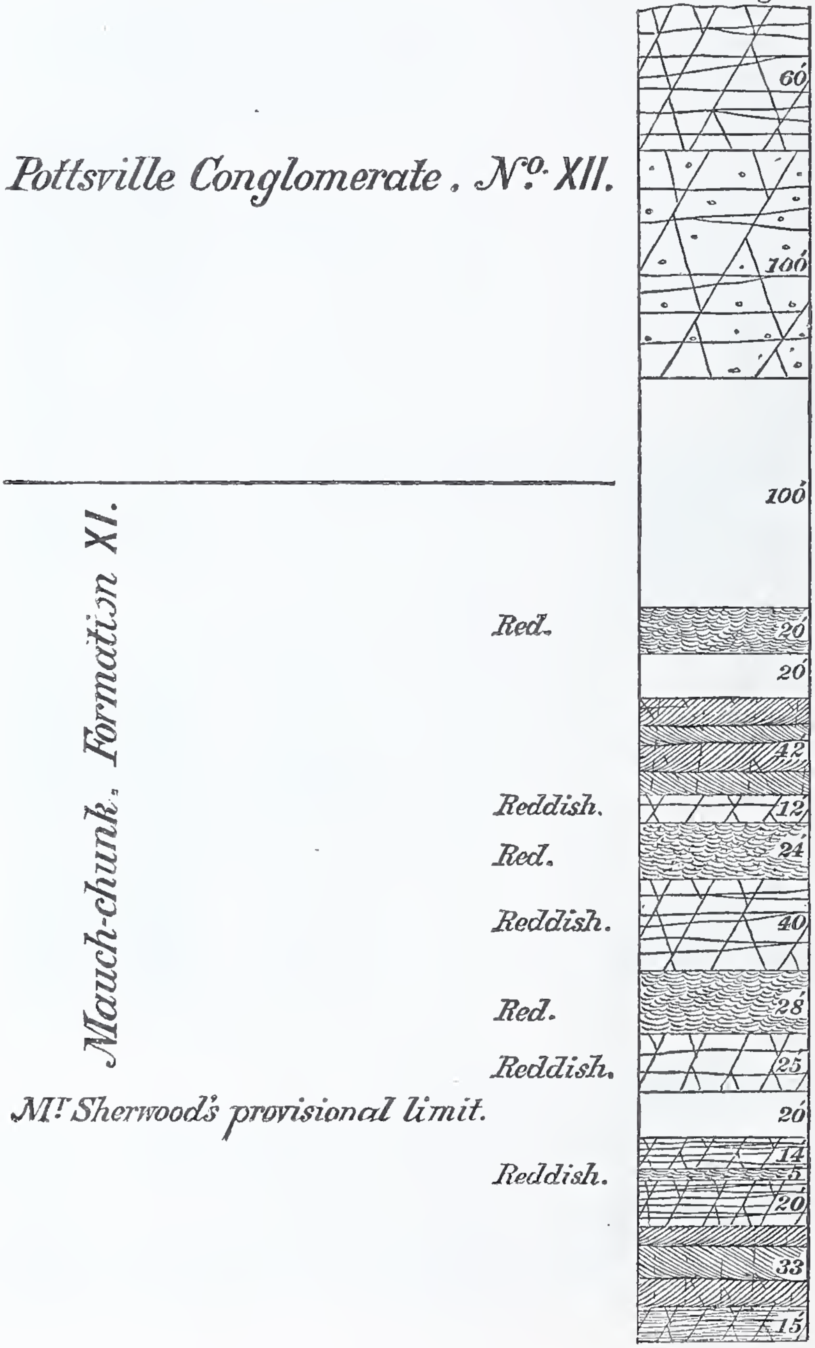
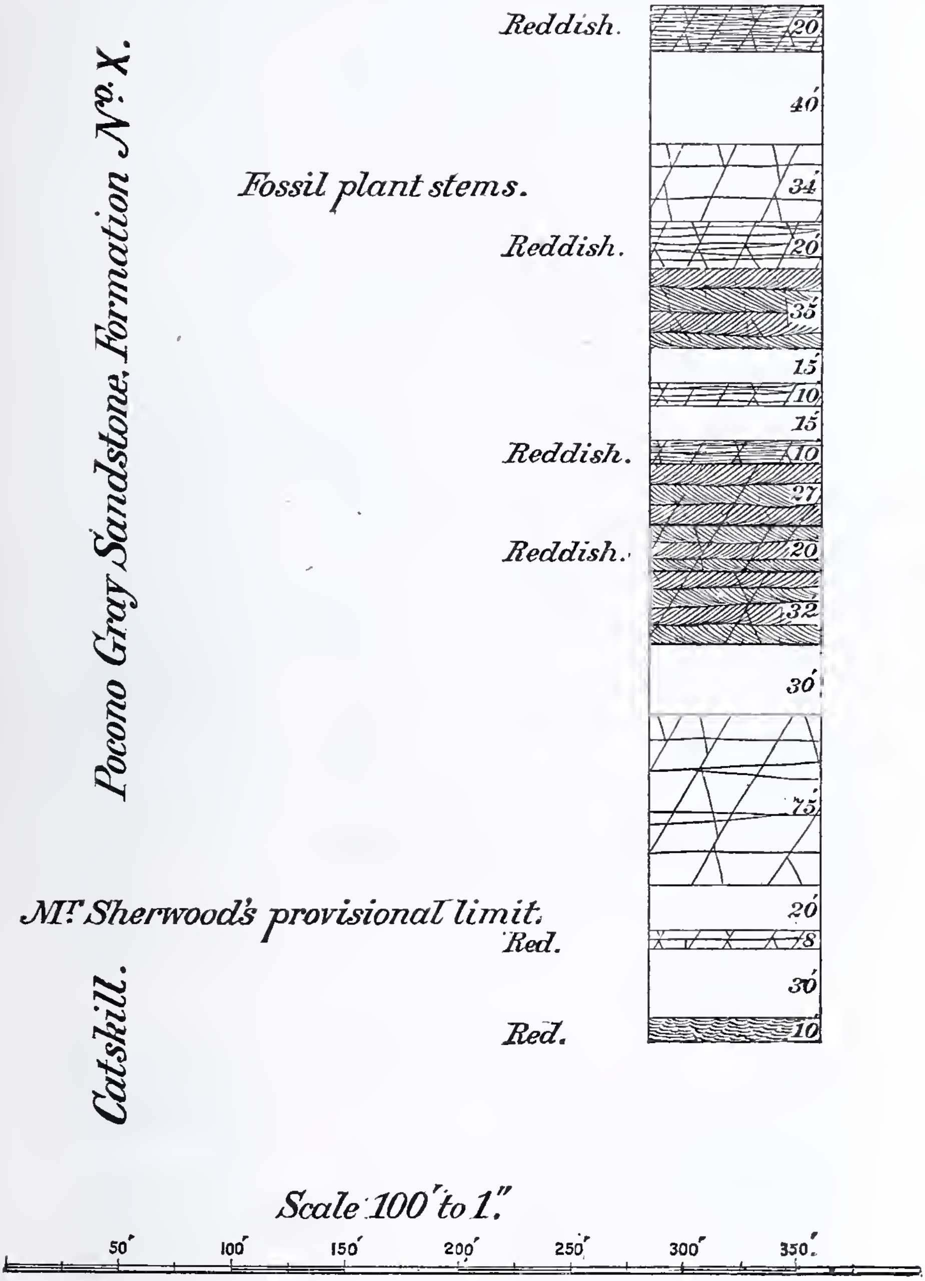

60'
Pottsville Conglomerate. No. XII.
100'
100'
Mauch-chunk. Formation XI.
Red.
20'
20'
42
Reddish.
12
Red.
24
Reddish.
40
Red.
28
Reddish.
25
Mr. Sherwood's provisional limit.
20'
14
Reddish.
5
20
33
15

Fig. 2. continued.



Section of North dipping Rocks on Trout Run Lycoming County.

Sec. 3. Fig. 3.

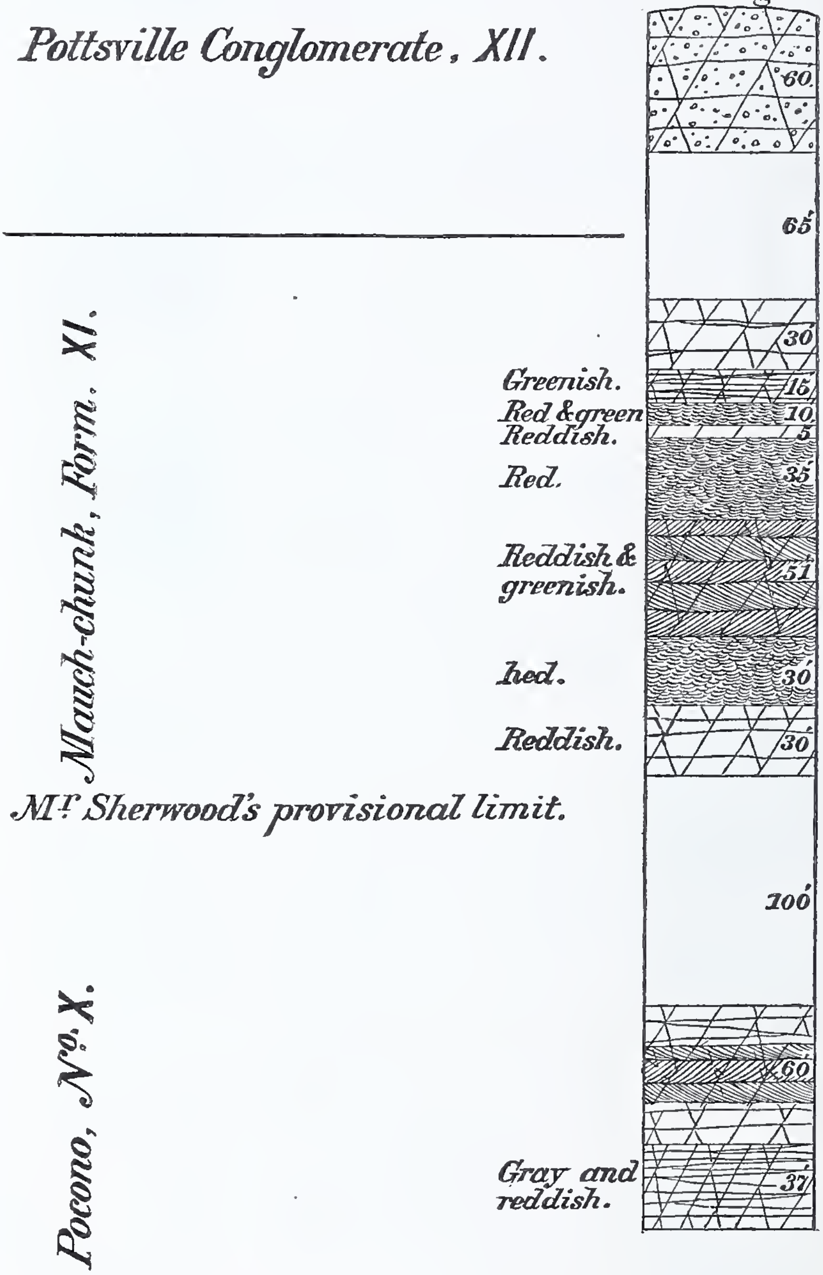
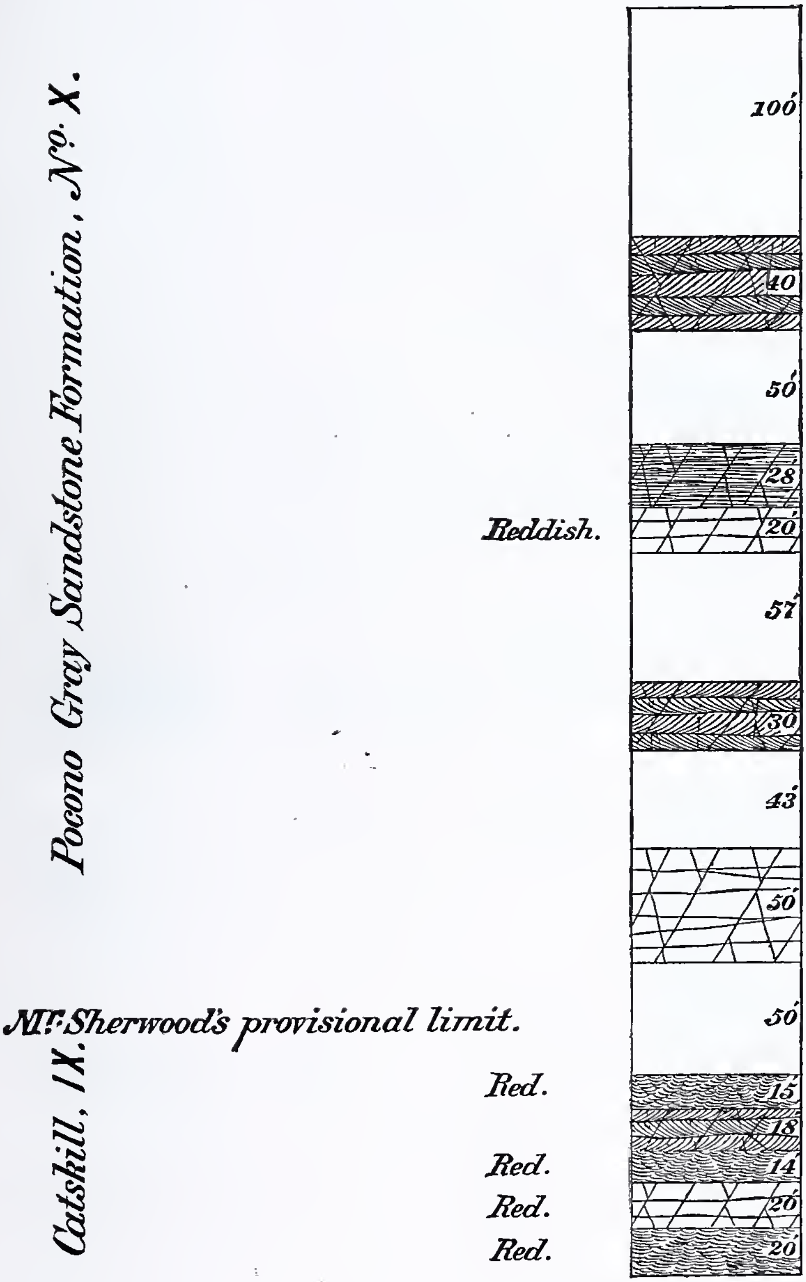
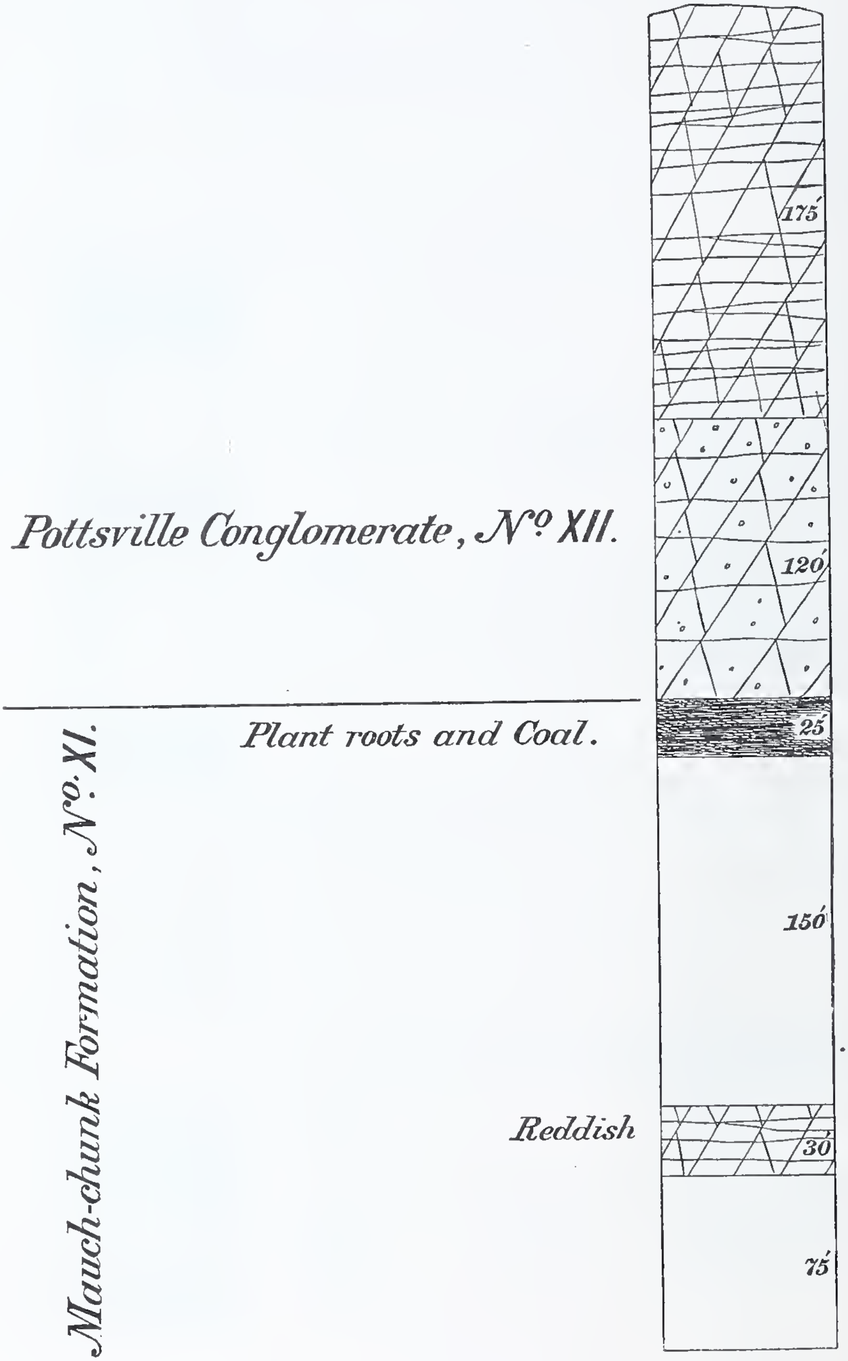


Fig. 3. continued.

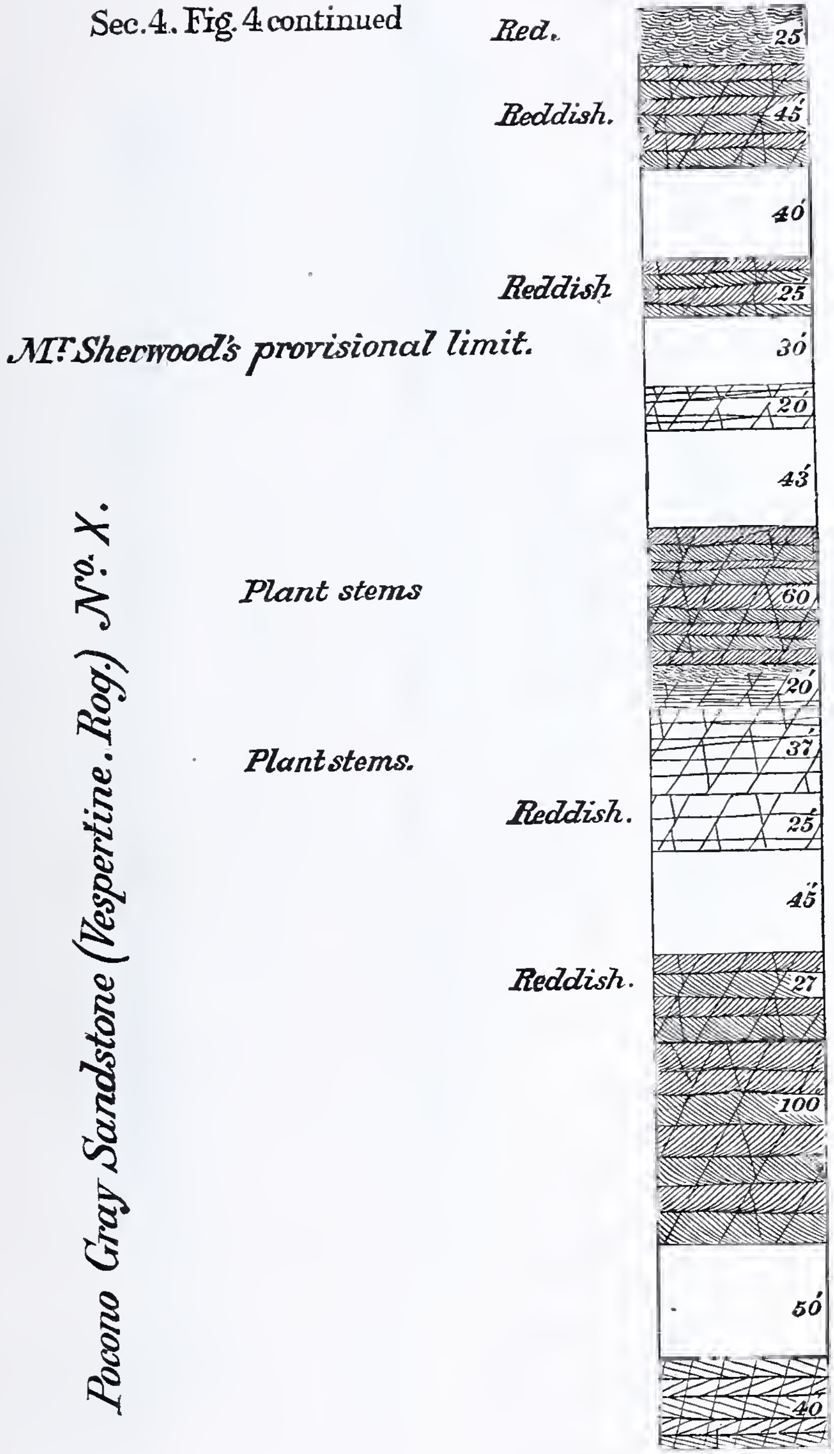


Section of South dipping Rocks
on the Loyalsock Lycoming County.

Sec. 4. Fig. 4.

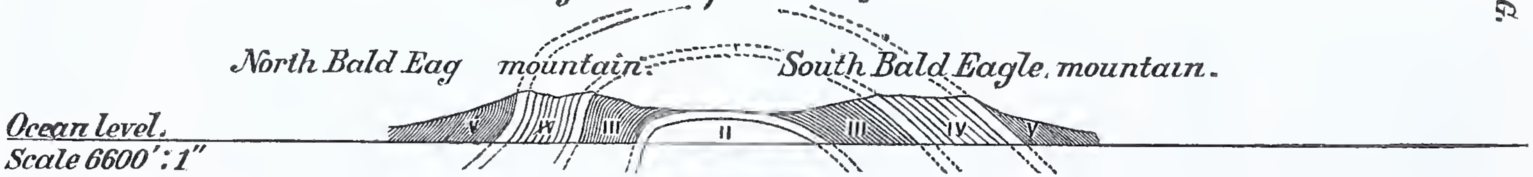

175'
Pottsville Conglomerate, Nº XII.
120'
Plant roots and Coal.
25'
Mauch-chunk Formation, Nº. XI.
150'
Reddish
30'
75'

Sec. 4. Fig. 4 continued



Armstrong township, Lycoming Co.

Fig. 5. Musquito Valley



Washington township, Lycoming Co.

Fig. 6. Nippenose valley.

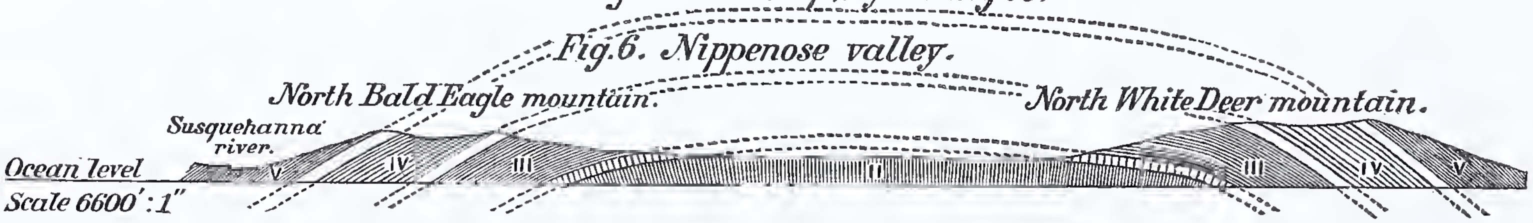
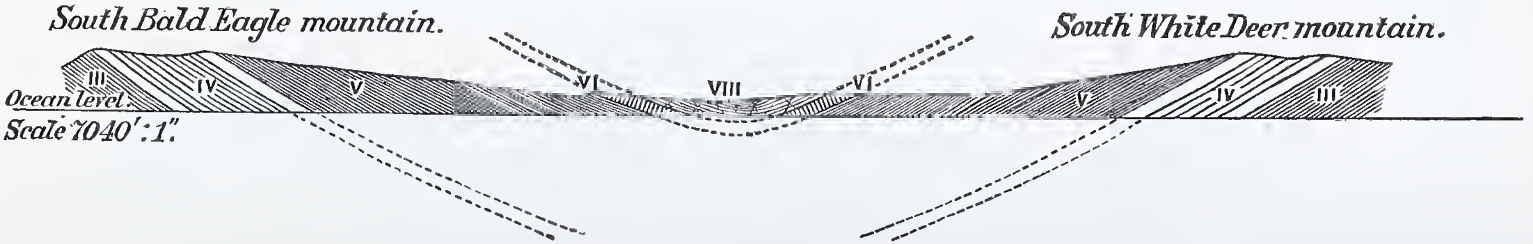


Fig. 7. White Deer valley.



General Geology of the Townships of Lycoming County, lying south of the Susquehanna River, with details of the Geological Structure.[*]

§31. While the geological structure of southern Lycoming makes numerous mountain crests and detached valleys, yet the theory of the structure can be briefly stated.

The anticlinal axis which brings up the limestone of II, and the slates of III, in Nippenose and Mosquito valleys to the northeast allows the mountain mass of IV to fold around it. This mountain mass again folds around in obedience to the beautifully defined synclinal axis of White Deer Valley, thus giving mountains of IV enclosing entirely the anticlinal valleys of II and III, and mountains of IV enclosing on three sides the synclinal valley of V, VI, VII and VIII in the White Deer Valley.

Such stated broadly is the general structure of this southern Lycoming County; the details of the structure being given under the head of the Townships.

§32. The geological formations embraced wholly or in part in southern Lycoming are as follows:

The Hamilton and Upper Helderberg; lower part of formation No. VIII (Devonian.)
The Oriskany sandstone, No. VII.
The Lewistown limestone (Lower Helderberg) &c. No. VI.
The Clinton red shales and fossil ore, No. V.
The Medina and Oneida group, No. IV.
The Hudson river slate group, No. III.
The Trenton limestone, &c. (Siluro-cambrian) No. II.

Of Formation VIII there can be little if any south of the Susquehanna River; but as soon as the river flat is reached the precise position of any one of the groups is necessarily vague, for the river wash covers all rock in place. The same formation however is in great thickness north of the Susquehanna and has already been sufficiently described in that part of this volume which relates exclusively to the Lycoming County region north of the River Valley.

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[*] By Franklin Platt.

Formation VII, the Oriskany sandstone does not show at all in southern Lycoming. Along the line of the Bald Eagle Mountain, at the Bellefonte Gap in Centre county, it is a massive flinty sandstone 50 feet thick.

Mr. Chance reports that he found it wanting at Lock Haven. Some exposures in Washington Township, in White Deer Valley, indicate that VII is also lacking, almost or altogether, in southern Lycoming.*

Formation VI, the Lower Helderberg Limestone is of considerable size in Lycoming. It lies however north of the Susquehanna River until, after passing near Muncy, it folds around the nose of the Bald Eagle Mountain, crosses the Susquehanna River and runs up into White Deer Valley. It is opened very little in the latter valley, nor does its entire thickness show except very imperfectly, but it is apparently not less than 250 feet and probably more. It is made up of limestone layers, blue and massive, interleaved with numerous layers of calcareous slate. Only a small part of the limestone is sufficiently pure to be used for burning for agricultural purposes and for plaster.

Formation V, the Clinton group is developed in Southern Lycoming county in great thickness. It spreads over a broad area, sweeping around the flank of Bald Eagle Mountain for many miles. The iron ores held by it are described in another chapter. The rocks making up the Clinton group are red sandstones, brown, gray, purple, red and chocolate colored slates and a few small layers of siliceous and worthless limestone. The total thickness of the Formation in this region is about 2000 to 2500 feet.

Formation IV, the Medina and Oneida sandstones, is very thick in Lycoming county, where it makes the Bald Eagle mountain crests and plateaus. It consists here, as in other localities, of the Upper gray sandstone, very massive and flinty, making the outer crest; the Middle red sandstone and shales, making a depression between the crests, and slightly cultivated in the hollows of the mountain plateau and the Lower gray sandstone, also hard and flinty, and making the inner crest.

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* For this non-conformability see H. D. Rogers in his Address before the A. A. Geol. Boston, 1842, p. 36, 37.

While there is no exposure which gives the exact thickness of these formations (Medina and Oneida) the probable measurements are somewhat as follows:

Upper hard sandstone,	100	1375 feet.
Middle red sandstone,	1200	
Lower hard sandstone,	75	

Formation III is exposed in Southern Lycoming county only as circling around inside of Nippenose and Mosquito valleys.

Lying as it always does on the outcrop side of a rough mountain slope of IV, its outcrop is covered in the greater part by a mass of débris from the crest of IV; and its junction with the limestone of II is rarely to be exactly located.

This makes the measurement of No. III somewhat indefinite; but in Lycoming county it seems to be about 800 feet in thickness. So far as exposed it is made up of gray and dark colored thin slates, with some calcareous layers always to be found in the vicinity of its junction with the limestone of II.

In Mosquito valley the Black Marble quarry is located somewhere about the junction of II and III, though it seems more properly to be included in II.

Formation II is only exposed in small part in Southern Lycoming county. It makes the country rock over the centre of the anticlinal arch of Nippenose valley. The arch however is narrow and not more than 1000 feet of the series are brought to daylight.

The limestones exposed are the usual gray, grayish blue and blue limestone and dolomites of the Siluro-Cambrian system. Many of the layers are tolerably pure limestone and are burned in the valley for agricultural purposes.

These 1000 feet of exposed limestones are only the upper part of formation II. The same formation is about 6000 feet thick in Blair county along the Juniata River, and is possibly therefore as thick in Lycoming county.

Topography of the Townships of Lycoming County lying south of the Susquehanna River.

§ 33. The topography of Lycoming county south of the Susquehanna river is divisible into three distinct belts, so widely differing from each other and so pronounced in structure as to show with marked plainness the nature of the formations and the character of the geological structure which has necessitated these striking differences. These belts are

1. *Such part of the Susquehanna Valley flat as may be included between the river on the north and the foot hills of the Bald Eagle mountain on the south.* This area is of varying width, the river at times sweeping away from the mountain and leaving a broad plain to the southward, and again hugging close by the mountain face, leaving an area so small that the Philadelphia and Erie Railroad had much cutting to do to secure a lodgment on the south side of the river.

This river flat, whatever be its area, is a smooth flat, with a rich and fertile soil, which is thoroughly cultivated. No rocks show in place in it; the wells of Williamsport and other towns in the valley find nothing but loose river débris even at 80 feet or more in depth below the surface.

The level of the Susquehanna River at Williamsport is 508 feet and this river flat therefore about 530 feet above the ocean.

2. *The Bald Eagle Mountain* covers the greater part of several townships.

It is not one mountain crest simply, but a somewhat complex series of mountains, joining to each other and causing high flat mountain plateaus, surrounding low lying anticlinal and synclinal valleys. The mountain crests are high, the summits reaching fully 1400 feet above the Susquehanna river or 1900 feet above the sea. The mountain slopes are steep upon both sides, having on them but little valuable timber, but always wooded with the common growths of hard woods. The coloring (on the map) for IV and V, the Oneida and Medina sandstones and the Clinton group, show the mountain area and how it covers nearly all of Lycoming county south of the river. The drainage of the mountain mass passes off partly by deeply gashed ravines on the mountain faces, and partly through deep gaps in the mountains, through which pass not only the surface drainage of the mountain plateaus but also the drainage of the enclosed anticlinal valleys. Nippenose creek for example, heads up in Nippenose valley in Limestone township, passes through the inner mountain gap, receives the Meadow Valley run which drains a valley of the middle of IV, then passes through the outer or northern mountain by a gap, and runs through Nippenose township entering the Susquehanna run nearly opposite to Jersey Shore.

Musquito creek in Armstrong township heads up on the inner mountain plateau, drains the anticlinal Mosquito valley, passes through a deep gap of Bald Eagle mountain and enters the Susquehanna river at Duboistown, 2 miles above Williamsport.

Rock run drains the inner mountain plateau of eastern Armstrong township, cuts through the Bald Eagle mountain; and enters the Susquehanna River at Rocktown, just below Williamsport.

The mountain masses of Washington and Clinton township drain into the White Deer valley and are carried off by White Deer creek, Spring creek, and Black Hole creek into the Susquehanna river.

3. The Valleys enclosed in the mountain mass.—In the very heart of this great mountain mass are two anticlinal valleys, Nippenose valley and Mosquito valley (or Jacks Hollow as it is locally termed) and the synclinal valley of Washington, Brady and Clinton townships called White Deer valley.

Nippenose Valley is in Limestone and Bastress townships of Lycoming county, and also at its western end crosses the county line and extends a short distance into Clinton county. The valley is regular in shape, and probably no more perfectly symmetrical oval anticlinal valley can be found in Pennsylvania.

The centre of the valley is very smooth and even, and is only some 300 feet above the Susquehanna river at Williamsport or 800 feet above the ocean. Around it on all sides rise the mountains of the Bald Eagle mountain mass, with crests some 800 or 900 feet above the centre of the valley. The whole valley was cleared for farming purposes at an early date and it is one of the best cultivated regions in the State.

Mosquito Valley is in Armstrong township. It is an oval anticlinal valley, much smaller than Nippenose valley, but of the same general appearance topographically. The centre of the valley is only about 800 feet above the ocean.

White Deer Valley is a synclinal valley, and therefore differs entirely from those already described. While the anticlinal valley are oval shaped and surrounded by mountain plateaus, the White Deer valley comes to a point and is closed on its southern end, but widens gradually on passing to the northward and on reaching the Susquehanna is a broad open valley, several miles in width. The valley is cut out deeply, its floor rising slowly from the Susquehanna river for many miles to the southward; at its south end it steepens quickly and ends up on the enclosing mountain crest. A noticeable feature of the topography is the low limestone ridge which runs along both sides of the valley, terminating however before reaching Elimsport. The mountains enclosing the valley rise very high, reaching 1900 feet above tide, thus making towering mountain crests above the deep valley. The level flat of White Deer valley is thoroughly cultivated, the timber having been long since cleared, and the land is in fertile farms.

CHAPTER II.

DETAILED REPORT OF THE TOWNSHIPS.*

Anthony and Lycoming Townships.

§34. These townships are bounded on the east by Lycoming creek, on the south by the Susquehanna, on the west by Mifflin township and on the north by Cogan House township.

The centre line of the Second synclinal touches the southwest corner of Anthony township, and from thence keeps in the edge of Woodward township, close to the township line.

The centre line of the Second anticlinal enters Anthony township from Mifflin about half a mile north from its southwest corner, and leaves Lycoming to enter Old Lycoming about midway of its south line.

The dip is south from this line to the bottom of the Second synclinal and north to the bottom of the Short Mountain, Hepburn and North Mountain synclinal.

The centre line of the Short Mountain, Hepburn and North Mountain synclinal enters Anthony from Mifflin about 2 miles north from its southwest corner, near the house of D. Getz, and leaves Lycoming to enter Hepburn where the railroad crosses Lycoming creek, at Hepburn village.

The centre line of the Tomb's run and Muncy Creek anticlinal enters Anthony township from Mifflin about midway of its west line between S. Marshall's and W. Kiby's, and leaves Lycoming to enter Hepburn at the mouth of Hoagland's run, opposite Cogan Station, and close to Perrysville.

From this line the dip is south to the bottom of the Short Mountain, Hepburn and North Mountain synclinal, and north to the bottom of the Waterville, Loyalsock and Bernice synclinal. This is a sharp anticlinal, the dips from it, both to the north and south, being very abrupt.

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* From notes by Mr. Sherwood.

A salient feature in the topography of Anthony and Lycoming is the mountain range touching their north borders, from which issue Larry's creek and the branches of Hoagland's run. The remainder of these townships is a rolling hill country, adapted to cultivation.

§ 35. Exposures of rock in place are not numerous; but even where nothing is exposed it is possible to judge pretty closely of the nature of the underlying rocks from the character of the soil and stones on the surface, as there is no drift except in the valleys of the streams.

The geological formations which make up the rocks in Anthony and Lycoming Townships are the Chemung, the Red Catskill (IX,) the Pocono (X,) with a very little of the Mauch Chunk (XI) and the bottom of the Pottsville Conglomerate (XII.) These latter are only on the highest summits at the centre of the synclinal. No coal has ever been found in or over XII.

The *Chemung* (VIII) occupies two narrow belts, one across the south side, and one through the middle, running north east and southwest.

The south belt is only about 1100 yards wide in Anthony township, over the centre arch of the Second anticlinal.

The middle belt is something over a mile in width over the centre arch of the Tomb's Run and Muncy Creek anticlinal.

The *Catskill* (IX) occupies a narrow belt only about 300 feet wide at the township line between Anthony and Woodward townships, mainly in Woodward, and in the Second synclinal.

It also occupies a wider northeast and southwest belt of two miles or more in width, in the Short Mountain, Hepburn, and North Mountain synclinal, in the south part of Anthony and Lycoming townships.

And again a belt in the north part of Anthony and Lycoming townships, of a mile or more in width, along the foot of the mountains.

The *Pocono* (X) makes up the mountain mass which crosses the north side of these townships in the Waterville, Loyalsock, and Bernice synclinal.

It is overlaid by the *Mauch Chunk* red shale (XI) and and the bottom of the *Pottsville Conglomerate of XII.*

The county map shows the exact limits of these formations.

§36. The Chemung rocks are composed principally of gray shales and sandstones; the Catskill of red clay slates and red sandstones, with interleaved gray sandstone layers, and the Pocono of fine and coarse gray flaggy sandstones, much current bedded, frequently greenish and micaceous, and with some small reddish layers of red sandstone or red slate.

Some of the more noticeable exposures of rocks in these townships are as follows:

Along the main road near the west line of Anthony township, and between W. Marshall's and A. Stabler's, *Chemung* gray sandstones cover the surface, containing very fine specimens of *Grammysia elliptica*, *Rhynconella contracta*, *Productus Boydii*, and other undetermined species.

In the road, a little north of J. A. Ulmer's store in Anthony township, the soil is of a deep red color, from the decomposition of Catskill red shales.

At J. Cook's blacksmith shop, near the south side of Anthony Township, 100 feet of gray and reddish shaly rock is exposed, dipping gently to the north. The geological horizon is at the bottom of the Catskill.

About 500 yards south of the last locality, in the main road, and near the forks of the Quenshehague, 40 feet of Chemung gray shaly rock is exposed, dipping gently to the north.

North of P. Groves, and about a mile and a half west of Perrysville, there are indications of iron ore, which is probably the same vein as that formerly worked on the east side of the Lycoming, in Hepburn township.

Mifflin and Watson Townships.

§37 These two townships lie west of Anthony and Lycoming. Mifflin is drained by Larry's creek and its branches while the main Pine creek drains Watson township.

The centre line of the Second synclinal axis just touches the southeast corner of Mifflin township.

The centre line of the Second Anticlinal axis is at the line between Watson and Porter townships. It enters Mifflin a mile and a quarter east from its southwest corner, crosses Larry's creek at the mouth of Canoe run, and leaves Mifflin to enter Anthony about 1000 yards north from its southeast corner.

From this line the dip is sharp to the south, to the bottom of the Second synclinal, and sharp to the north, to the bottom of the Short Mountain, Hepburn, and North Mountain synclinal.

The centre line of the Short Mountain, Hepburn and North Mountain synclinal axis enters Watson township from Clinton county, where the old Coudersport and Jersey Shore turnpike goes over the top of the first mountain after leaving Pine Creek. It crosses Pine Creek 1 mile above the mouth of Furnace Run, leaves Watson to enter Mifflin about three quarters of a mile north from its southwest corner, and leaves Mifflin to enter Anthony Township about one and three quarter miles north from its southwest corner.

The centre line of the Tomb's run and Muncy creek anticlinal axis comes up from the southwest out of Clinton county; crosses Pine creek at the mouth of Tomb's run, leaves Watson to enter Mifflin township near the westernmost point of the latter, and leaves Mifflin to enter Anthony township near where Larry's creek crosses the township line.

From this line the dip is south to the bottom or centre line of the Short Mountain, Hepburn and North Mountain synclinal axis, and north to the bottom or centre line of the Waterville, Loyalsock and Bernice (Allegheny) synclinal axis.

The centre line of the Waterville, Loyalsock and Bernice synclinal axis passes through the north part of Mifflin township, crossing the second fork of Larry's creek near the mouth of Francis run.

The north half of Mifflin township is an elevated mountainous region, cut through by the branches of Larry's creek; while the south half, with the exception of the bold point of Short mountain, which ends abruptly on the west side of Canoe run, is a rolling hill country, adapted to farming and grazing.

§38. The most notable feature in the topography of Watson is the way in which the short anticlinal valley of Tombs run and Muncy creek heads up in a broad amphitheatre, after running in between Short mountain and the main Allegheny Ridge for a distance of about 4 miles. The remainder of Watson is a mountainous region through which are excavated the deep gorges of Pine creek and Gamble's run.

§39. The geological formations which make the country of Mifflin and Watson townships are the Chemung, the Catskill (IX,) the Pocono (X,) and at the centre of the synclinal, on the hill summits, a small area of the Mauch Chunk red shales (XI) and the bottom massive layer of the Pottsville Conglomerate (XII.) No coal has ever been found in or on the latter rock.

The *Chemung* occupies a narrow belt across the south side of Watson township, over the arch of the Second anticlinal axis.

Also a small area on Larry's creek, above Salladasburg, on the Tomb's run and Muncy creek anticlinal.

The *Catskill*, in Mifflin township, occupies a belt about two miles in width in the Short Mountain, Hepburn and North Mountain synclinal basin, and over the Tomb's run and Muncy creek anticlinal.

It also occupies the gorge of the second fork of Larry's creek.

In Watson township the Catskill (IX) occupies the surface of the Tomb's run and Muncy creek Anticlinal valley where it heads up at Pine creek; also the gorges of Pine creek and Gamble's run, and a narrow belt along the south side of Short mountain.

The *Pocono* (X) makes up the mass of the Porterbaugh (Allegheny) mountain in the northern half of Mifflin; also the mountains in Watson, including Short mountain, which terminates in the southwest corner of Mifflin.

Above the Pocono come in the Mauch Chunk red shale XI and the conglomerate of XII, but only over a limited area.

In character the Chemung, the Catskill and the Pocono resemble the same formations as already described in Anthony and Lycoming townships.

§ 40. There are numerous exposures in place in Mifflin and Watson townships. These are imperfect in that they only take in at one place, a part of a single formation; but together they seem to present somewhat clearly the nature of the whole rock groups. The details are as follows:

On the second fork of Larry's creek, between E. Doctor's and J. Gilbert's, in the northwest corner of Mifflin township, 10 feet of Gray sandstones, (probably Pocono No. X) are exposed, with thin coal seams. These coal seams are no indication, as many have supposed, of thicker veins further in the hill.

Where the Big and Little Harbor runs enter the second fork of Larry's creek, there are great masses of massive conglomerate in loose bowlders.

At W. Cohick's, where the second fork of Larry's creek comes through the mountains, red sandstones, belonging to the Red Catskill, dip to the northward.

Near Salladasburg, between the forks of Larry's creek, 40 feet of red shaly rock is exposed, belonging to the Red Catskill, and dipping probably a little to the south.

About 2 miles west of the last locality, beyond W. Tackeberry's, and near the forks of the road, red shale and sandstone is exposed, belonging to the Red Catskill and dipping to the northward.

About a mile from Salladasburg, a little south of west, and near the forks of the road, the same kind of rock as that last mentioned is exposed, dip not seen.

Just below Salladasburg, at T. J. Watt's, and again near J. Maneval's, the same kind of rocks are again exposed, having apparently a gentle south dip.

Where the road crosses Larry's creek, about 1 mile below Salladasburg, there is an interesting exposure of red shale and gray sandstone belonging to the Red Catskill. At the north end the beds are nearly horizontal; at the south end they dip a little west of north at a high angle.

Where the road first crosses the creek again below this place about half a mile, at F. Friedal's, 10 feet of Chemung gray shaly rock is exposed, dipping rapidly to the north.

§ 41. *Iron Ore.*—Half a mile below the last, upon the hill east of the creek, there is a vein of iron ore averaging two feet in thickness, which was worked quite extensively some 20 years ago by the Danville Iron company. It is the same as the Mansfield Ore found in Tioga and Bradford counties.

A little below, at the line between Mifflin and Piatt, there are rapidly south dipping Chemung gray rocks.

On Canoe Run, at Jacob Secrist's, J. Borger's, and J. M. Miller's, the same vein of iron ore referred to above has been opened and mined to some extent by the Danville Iron company. It averages about 2 feet in thickness, and contains *shells* and *fish remains*. The dip is at a very high angle to the north, being nearly perpendicular. It is close under red rocks, *in the top of the Chemung.*

About 300 yards north of the last locality, between S. Fink's and C. Chamberlain's, 40 feet of red shales, belonging the Red Catskill are exposed. It is nearly perpendicular, being slightly inclined to the north.

About 300 yards above the mouth of Furnace run, on Pine creek, in Watson township, the Red Catskill begins and is exposed along the road for about half a mile, the beds dipping north at a high angle. The thickness of these red beds is apparently some twelve hundred to fifteen hundred feet.

Just above T. Brown's, near the upper end of an island in Pine creek, the soil and stones are gray, derived probably from the Pocono No. X; but whether from the hill above, or whether the narrow and deep synclinal crossing here brings strata of this formation in place down to the bed of the stream could not be determined from the imperfect exposures.

Below the mouth of Gamble's run some red rocks of the Red Catskill group are exposed, having a rapid south dip.

About one half way between the mouth of Gamble's run and Tomb's run over 40 feet of red rocks of a similar kind show in place; the exact dip could not be seen.

A little above the mouth of Tomb's run, in the West bank of Pine creek, 100 feet of the same kind of red rock is again exposed, dipping considerably to the northward.

About one mile above this place, on the same side of the stream, there is another locality, thickness unknown, which includes all the rock exposures of any note met with in Watson Township.

Porter, Piatt, Woodward and Old Lycoming Townships.

§ 42. These four embrace a considerable area along the north side of the valley of the Susquehanna river and along Pine creek. The exact area embraced in these limits is shown on the outline township map, and needs no further elaboration.

On the geological map of the county some lines are drawn across these townships which are called the First and Second synclinal axes and the First and Second anticlinal axes. This structure is not always clear in some localities, while in other places the strata seem to be folded into narrow synclinals, separated, of course, by as many sharp anticlinals. The second synclinal for instance is well marked through Piatt and Woodward, where it carries a narrow belt of red rocks.

The surface of these townships is a rolling hill country, adapted to farming and grazing.

§ 43. The surface rocks in Porter, Piatt, Woodward and Old Lycoming all belong to the Chemung and Red Catskill groups, except in those parts adjoining the Susquehanna river, where rocks older than the Chemung are brought to the surface, including a bed of limestone [of VI] which is worked at some points. The observations, as recorded in this chapter, have stopped with the Chemung.

The *Chemung* occupies the north half of *Porter* township, north of a line running northeast from Dodge, Stokes & Co.'s mills on Pine creek, except in a narrow belt on the east side, in the Second synclinal basin, and a little corner on the north, in the Short Mountain synclinal basin, which are occupied with the *Red Catskill.*

The *Chemung* occupies that part of *Piatt* township north of a line running northeast from the mouth of Larry's creek, except a narrow belt of a few hundred feet in width in the Second synclinal, which is occupied with the *Red Catskill.*

The *Chemung* occupies that part of *Woodward* township north of a northeast and southwest line drawn so as to touch the Susquehanna river at the mouth of Quenshehague creek, near Linden, except a narrow belt of about 300 feet in width in the Second synclinal, at the line between Woodward and Anthony townships, which is occupied with the *Catskill.*

The *Chemung* occupies that part of *Old Lycoming township* north of the corporation of Williamsport, except a little area in the Second synclinal basin which is occupied by the Catskill.

The Chemung group is composed of gray shales and sandstones, having a great thickness in all. Judging from the section on Pine creek, this thickness must be over 3000 feet. But the strata are much contorted; and, with imperfect exposures, under such circumstances, it is only possible to approximate to the total thickness.

The Catskill group is composed of red shale and sandstone. Only the lower beds of this formation are found in these townships, and these over very limited areas, as will be seen by the colored geological map of the county.

§ 44. There are numerous exposures of rocks in place in these townships. Some of these are as follows:

On Pine creek, near S. H. Bailey's, and a little south of west from Jersey Shore, there is a *limestone quarry.* It is the same bed as that worked below Williamsport [limestone of VI].

Near Jersey Shore, on the road to Phelps' mills, 20 feet of black and dark colored shale is exposed.

§ 45. *Section.*—One third mile above Dodge, Stokes & Co.'s mills, in Porter, and on the road running up Pine creek, there is the beginning of an extensive and interesting section, which extends along the road for a distance of about 2 miles, terminating in Watson township, about 300 yards north of Furnace run. These rocks are greatly disturbed. There are three slips or faults in sight, at each one of which the rocks are ground to powder. In a distance of 8432 feet there are 1600 feet of Chemung gray rocks exposed at intervals, and generally approaching the perpendicular. The remaining 6832 feet of rocks are concealed.

In only one bed were fossils observed; a thin calcareous band, 1 foot thick, containing *spirifer disjuncta.*

There are no signs of any red rocks until about 1240 feet north of Furnace run, where the soil is decidedly deep red colored, though it is difficult to say whether the coloration be due to the presence of an iron ore layer or simply from red shale.

About 100 feet further on, red rocks begin and extend uninterruptedly for a distance of at least 1000 feet, perhaps as much as 1500 feet, as it is difficult to say just exactly where they terminate, being concealed occasionally for a distance, and moreover much contorted.

The rocks are standing nearly on end, dipping steeply to the north.

As nearly as could be calculated from the imperfect exposures, these rocks are from twelve hundred to fifteen hundred feet thick; certainly not less than one thousand feet. The section terminates at T. Brown's, in Watson township, where the narrow, but deep, synclinal axis of Short mountain crosses Pine creek.

§ 46. Three quarters of a mile below Larry's creek P. O., in Piatt, there is a *limestone quarry*, which is the same bed as that worked below Williamsport [limestone of VI].

At Larry's Creek P. O. the rocks are greatly disturbed, standing nearly on end. They appear to belong to the Chemung group.

§ 47. *Section.*—About one and a half miles north of the P. O., where the creek makes a singular bend, there are some interesting exposures. Along the plank road, near the Methodist church, there are 50 feet of north dipping gray rocks, interleaved with some beds of a reddish color. A little north from this locality across the creek and near the grist-mill, there is a good exposure of 75 feet of rapid north or northeast dipping red rocks.

A little further north along the plank road, and near the house of F. Thomas, there are 30 feet of rapid south dipping red rocks. A few rods further to the north, at the forks of the road, there are over 50 feet of the same character of red rocks exposed, dipping rapidly to the south and passing under the last named locality.

A short distance northeast from Linden, where the road crosses Quenshehague creek, in Woodward township, 75 feet of Chemung gray shales are exposed, with a steep north dip, the beds being *folded back* upon themselves at the north end of the cliff.

Half way between C. Stewart's and W. H. Carson's, a Chemung gray shaly rock, somewhat concretionary, is exposed, having a considerable and steady south dip. A few rods further to the north, at the forks of the road, the dip is much sharper to the south, while a little further on, in the same direction, it is more gentle. Thickness of beds exposed, 75 feet.

§ 48. Two miles further up the Quenshehague, between the mouth of Kulp's run and a school house, 20 feet of Chemung gray rocks are exposed, with a heavy north dip, being indeed nearly perpendicular.

One third of a mile further on, Chemung gray rocks are standing on end.

Where the Quenshehague crosses the line between Woodward and Anthony townships, red and gray rocks are exposed along the road, with heavy dips. The dip is reversed four times in a distance of 300 feet.

§ 49. *Iron ore.*—Just on the edge of Anthony and about 100′ below the red rocks, there is a *thin bed of iron ore* which has been worked on a small scale. It dips rapidly to the south, and contains traces of shells.

The belt holding the red rocks is only about 300 feet in width, and marks the bottom of a deep and narrow synclinal basin. It is an interesting locality.

Hepburn, Eldred and Loyalsock Townships.

§ 50. These lie chiefly between the Lycoming creek and Loyalsock creek, and north of the Susquehanna river.

The centre line of the Tomb's run and Muncy creek anticlinal enters Hepburn township from Lycoming township at Cogan station, and runs through the centre of Hepburn and Eldred townships to Loyalsock creek at Loyalsock village.

From this line the dip is north to the bottom of the Loyalsock synclinal and south to the bottom or centre line of the Short mountain, Hepburn and North mountain synclinal.

The centre line of the Short mountain, Hepburn and North mountain synclinal enters Hepburn township from Lycoming township at Hepburn village about one and a quarter miles south from the centre line of the Tomb's run and Muncy creek anticlinal axis with which it runs parallel across Hepburn and Eldred townships.

The description of the lines representing the First and Second anticlinal axes and the First and Second synclinal axes is already given in Porter, Piatt, Woodward and Old Lycoming townships applies to the same lines as drawn across Loyalsock township and need not be repeated. (See § 42 above.)

§ 51. The surface of Eldred, Hepburn and Loyalsock is a rolling hill country, except a little area in the north corner of Eldred township, where the Allegheny ridge rises abruptly to the height of several hundred feet above the valleys.

The *Chemung* and *Catskill* groups are the surface rocks in *Hepburn* township.

The Chemung occupies a belt of a mile in width through the centre of the township, from the east to the west, over the arch of the Tomb's Run and Muncy creek anticlinal axis.

The Catskill covers the remainder of the township, comprising a belt on the north, at the foot of the Allegheny ridge, and another on the south in the Short mountain, Hepburn and North mountain synclinal.

The *Chemung*, *Catskill* and *Pocono* groups make up the country rock of *Eldred* townships.

The Chemung occupies a belt of a mile in width through the centre of the township, from east to west, over the arch of the Tomb's run and Muncy creek anticlinal.

The Catskill is at the surface between this Chemung belt and the Allegheny ridge on the north, and between the Chemung and Allegheny line on the south, in the Short Mountain, Hepburn and North mountain synclinal basin.

The Pocono makes up the mass of the mountain, crossing the northern part of the township, and known here as the Allegheny ridge.

The *Chemung* and *Catskill* groups make the country rock of *Loyalsock* township, except in that part bordering the Susquehanna river, where older rocks reach the surface, including a bed of *limestone* [limestone of VI].

The Chemung covers nearly the whole of the area embraced in the township.

The Catskill only touches the northern portion of the township.

§ 52. There are numerous exposures of parts of the different groups in various parts of these townships. These exposures are as follows:

In the bend of the Lycoming Creek, at Crescent, 40 feet of Catskill shale and sandstone are exposed, dipping gently to the north. Some of the sandstone is highly micaceous.

Half a mile below the last locality in the narrows of Lycoming creek, below the nail factory, 75 feet of red rocks are exposed belonging to the Catskill group, and having a considerable dip to the north.

Iron ore.—On land of P. R. Hays, half a mile above Cogan station, is a vein of iron ore from 2 to 4 feet thick, which has been worked quite extensively, and the ore taken to Danville. It is the Mansfield iron ore, and contains *fish* *remains* and *shells*, the same as are contained by the iron ore at Austinville, in Bradford county. The dip is very heavy to the north, the vein being nearly perpendicular. It is *reported* that there are three beds of ore at this place.

Near Cogan station, where the road crosses Long Run, there is an exposure of Chemung gray shaly rock with a sharp south dip.

A little further down the stream, where the road crosses Rock run, a soft gray Chemung shale rock has a sharp south dip.

Half way between the last locality and the Presbyterian church, near the railroad crossing, there are red rocks, belonging to the Catskill group, with a south dip.

One mile east of Warrensville, in Eldred township, and on the road to Loyalsock, 15 feet of soft gray Chemung rocks are exposed. The dip is obscured.

Limestone is quarried and burned at several places along the road between Williamsport and Montoursville in Loyalsock township [limestone of VI].

Upper Fairfield, Fairfield, Muncy, Wolf and Shrewsbury Township.

§ 53. These townships lie between the Loyalsock creek and Muncy creek, and north and northeast of the Susquehanna river.

The centre line of the Tomb's run and Muncy creek anticlinal runs from Loyalsock P. O. in Upper Fairfield township, to Tivoli in Shrewsbury township, and leaves Lycoming county to enter Sullivan county where Muncy creek crosses the county line.

From the centre of the anticlinal axis the dip is to the north to the bottom or centre line of the Loyalsock synclinal, and south to the bottom or centre line of the Short mountain, Hepburn, and North mountain synclinal.

The centre line of the Short mountain, Hepburn and North mountain synclinal runs parallel with the Tomb's run and Muncy creek anticlinal from a point on the Loyalsock half way between Loyalsock P. O. and the southwest corner of Upper Fairfield township to Picture rocks in Wolf township.

The description already given in previous townships concerning the First and Second anticlinal and synclinal axes will apply to the lines representing those axes through these townships. (See § 42 and 50 above.)

§ 54. The surface of the county is rolling, and similar to that already described, with the following surface rocks:

The *Chemung* and *Catskill* groups make the country rock in *Upper Fairfield* townships.

The Chemung comes to the surface over the arch of the Tomb's run and Muncy creek anticlinal, making a belt of about one mile in width through the central part of the township.

The Chemung is also brought to the surface again on the south side of the township, by what is called on the map the Second anticlinal axis.

The Catskill covers that part of the township lying north of the Chemung belt already described.

The Catskill also occupies a belt of about a mile and a quarter in width in the Short mountain, Hepburn and North mountain synclinal basin, in the southern half of the township, between the two Chemung belts.

§ 55. The *Chemung* group makes the surface rock in *Fairfield* township, except in the southern part, where older rocks are brought up, including the bed of limestone previously mentioned [limestone of VI].

§ 56. The *Chemung*, the *Catskill*, and the *Pocono* group make the country rock of *Muncy* township, except in the southern part where the older formations with the limestone [of VI] already alluded to come to the surface.

The Chemung rocks run across the township in two belts, one of them a full mile in width, over the centre of the Tomb's run and Muncy creek anticlinal, and the other still broader belt through the central part of the township.

The Catskill separates these two belts by a belt of a mile and a quarter in width, in the Short mountain-Hepburn-North mountain synclinal.

It also covers that part of the township lying north of the first mentioned Chemung belt, except a little at the township line between Muncy and Plunkett's creek townships, where the Allegheny ridge is capped by the Pocono group.

§ 57. The *Chemung* and *Catskill* are the surface rocks in *Wolf* township, except in the southern part, where older formations are brought up to the surface including the bed of limestone already mentioned [the limestone of VI].

The Chemung rocks run across the township from east to west in two belts, one at Villa Grove and one north of Picture Rocks.

These belts are separated by a belt of Catskill, in the Short mountain, Hepburn and North mountain synclinal, which crosses the township at Picture Rocks.

The *Catskill* also covers the northern part.

§ 58. The *Chemung*, the *Catskill* and the *Pocono* are the country rocks in *Shrewsbury* township.

The Chemung is exposed along Muncy creek.

The Catskill covers the remainder of the township, except in the northern part, where the Pocono group caps the summit of the Allegheny ridge.

§ 59. The opportunity for detailed study of the different groups is very favorable in all these townships. The details are as follows :

§ 60. *Section of Chemung measures.*—Where the bridge crosses the Loyalsock, a little above Loyalsock, there is an extensive and highly interesting exposure. The rocks have a heavy and steady dip to the north.

The thickness of the beds is 1080 feet (334 feet of which are concealed,) all in a distance of about 1650 feet.

In the following section most of the beds are gray and contain Chemung fossils, and must therefore be considered as belonging to the Chemung group. But No. 78 of the section is the last rock (at the top) which can be called Chemung. The other beds above that belong to the Catskill.

But it will be seen that red colored beds occur at lower levels, showing a gradual transition from one formation to the other. It is seldom that a section like this can be obtained just at that particular horizon where the Chemung and Catskill groups meet.

No. 70 of the Section is probably the representative of that remarkably persistent bed, the *Mansfield iron ore.*

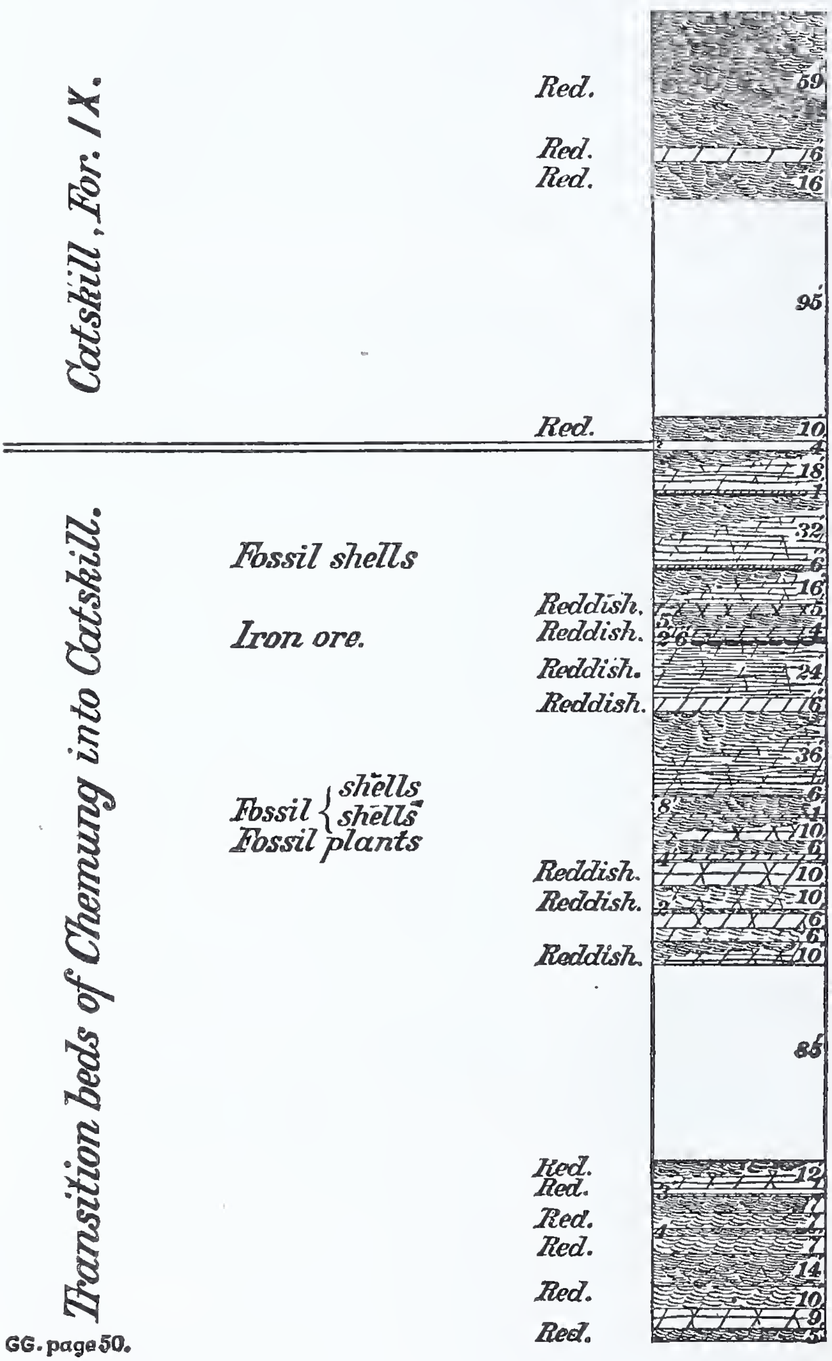
It will be noticed that there are 16 calcareous bands occurring at intervals, which contain fossils of well known Chemung species. But while shells are numerous, nothing is seen which answers to the plant beds so often found in Bradford and Susquehanna counties, excepting Nos. 17 and 62 of the Section.

Section 5, Fig. 8, at Bridge over Loyalsock creek above Loyalsock village, in Upper Fairfield township.

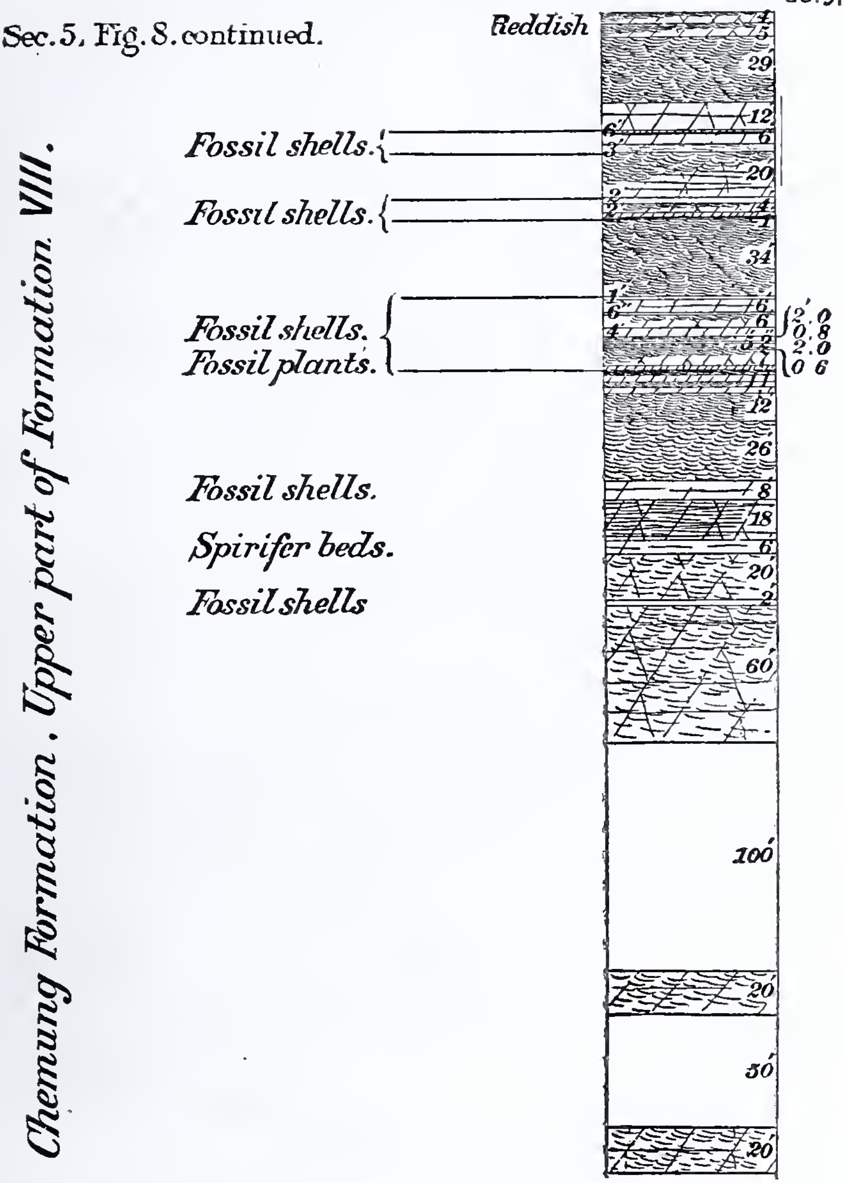
84.	Shale, *red,*	CATSKILL	59'
83.	Sandstone, *red,*		6'
82.	Shale, *red,*		16'
81.	*Interval concealed,*		95'
80.	Shale, *red,* [bottom of IX ?]		10'
79.	*Interval concealed,*		4'
78.	Shale, gray, and shaly rock,	TRANSITION BEDS	18'
77.	Sandstone, gray,		1'
76.	Shale, gray, and shaly rock,		32'
75.	*Calcareous* rock, *with fossil shells,*		0 6"
74.	Shale, gray, and shaly rock,		16'
73.	Sandstone, shaly, *reddish,*		5'
72.	Shale, gray,		5'
71.	Shaly rock, gray and *reddish,*		4'
70.	*Mansfield ? Iron ore,* with partings of *red shale,* and containing *fossil shells,*		2' 6"
69.	Shaly rock, gray and *reddish,*		24
68.	Sandstone, shaly, *reddish,*		6'
67.	Shale, gray, and shaly rock,		36'
66.	*Calcarcous* rock, with *fossil shells,*		0' 6"
65.	Shale, gray,		8'
64.	*Calcareous* rock, with *fossil shells,*		1'
63.	Shale, gray, and sandstone,		10'
62.	Shale, gray, with *plant stems,*		6'
61.	Sandstone, gray,		3'
60.	Shale, gray,		1'
59.	Sandstone, *reddish,*		10'
58.	Shaly rock, *reddish,*		10'
57.	Shale, gray,		2'
56.	Sandstone, gray,		6'
55.	Shaly rock, gray,		6'
54.	Shale, *reddish,* and sandstone,		10'
53.	*Interval concealed,*		85'
52.	Shale, *red,* and sandstone,		12'

Section on the Loyalsock Creek.

Sec. 5. Fig. 8.

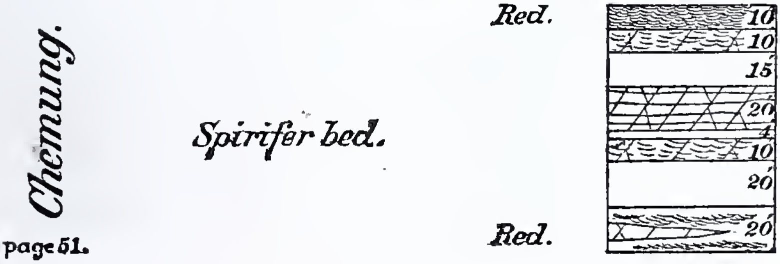


Sec. 5. Fig. 8. continued.



800 Y^ds^ E. of Loyalsock P.O.

Sec. 6. Fig. 9.



51.	Sandstone, gray,		2′
50.	Shale, *red*,		1′
49.	Shale, gray,		7′
48.	Shale, *red*,		7′
47.	Shale, gray,		4′
46.	Shale, *red*,		7′
45.	Shale, gray,		14′
44.	Shale, *red*,		10′
43.	Sandstone, gray,		9′
42.	Shale, *red*,		5′
41.	Shale, gray, and sandstone,		4′
40.	Shale, *reddish*, and sandstone,		5′
39.	Shale, gray,		29′
38.	Sandstone, gray,		12′
37.	*Calcareous* rock, with *crinoid stems*,		0′ 6″
36.	Sandstone, gray,		6′
35.	*Calcareous* rock, with *fossil shells*,		3′
34.	Shale, gray, and shaly rock,		20′
33.	*Calcareous* rock with *fossil shells*,		2′
32.	Shaly sandstone, gray,		4′
31.	Sandstone, gray,		2′
30.	Shale and *Calcareous* rock, with *fossil shells*,		1′
29.	Shale, gray,		34′
28.	*Calcareous* rock, with *fossil shells*,		1′
27.	Shaly rock, gray,		6′
26.	*Calcareous* rock, with *fossil shells*,		8′ 6″
25.	Sandstone, reddish, and shale,		6′
24.	Calcareous rock, Sandstone, with *fossil shells*,		4′
23.	Shale, gray,		2′
22.	*Calcareous rock*, with *fossil shells*,		0′ 8″
21.	Shale, red and gray,	CHEMUNG	2′
20.	*Calcareous rock*, with *fossil shells*,		0′ 6″
19.	Shale, gray, and sandstone,		7′
18.	Sandstone, gray,		2′
17.	Shale gray; parting contains *plant stems*.		
16.	*Calcareous rock*, with *fossil shells*,		2′
15.	Shale, reddish, and sandstone,		3′
14.	Shale, gray,		2′
13.	Sandstone, reddish and brownish,		2′
12.	Shale, reddish,		12′
11.	Shale, gray,		26′
10.	*Calcareous rock*, with *fossil shells*,		8′
9.	Sandstone, shaly, gray,		18′
8.	*Calcareous* rock, with *spirifers*,		6′
7.	Shaly rock, gray,		20′
6.	*Calcareous* rock, with *fossil shells*,		2′
5.	Shaly rock, gray,		60′
4.	*Interval concealed*,		100′
3.	Shale and shaly rock, gray,		20′

2.	*Interval concealed,*	50′
1.	Shaly rock, gray,	20′
	Total	1080′ 8′′

Section 5, Fig. 9.—About 800 yards east of Loyalsock P. O. the following beds are exposed having a heavy dip to the north. They are numbered from the bottom up:

8.	Red shale,	10′
7.	Shaly rock, gray,	10′
6.	*Interval concealed,*	15
5.	Sandstone, shaly, gray,	20′
4.	*Calcareous* rock containing *spirifers,*	4′
3.	Shaly rock, gray,	10′
2.	*Interval concealed,*	20′
1.	Red shale and gray sandstone,	20′
	Total,	109′

About 300 yards east of the last locality on the same road and near the house of T. Holmes, red shale dips north.

Where the same road crosses the left hand fork of Mill creek, is an exposure of 5 feet of red shale dipping north.

Where it crosses the right hand fork at J. Fagle's, 20 feet of red shale rocks show dipping north.

§ 61. *Conglomerate.*—Near the last two localities there are numerous bowlders of the Pottsville conglomerate of XII derived from the mountains to the north.

At Fairfield Centre show 10 feet of gray shaly rock.

In the south part of the township, at J. M. Entz's, gray shale rocks are exposed.

At G. Waltz's red shale rocks are exposed.

At J. Collins', near the south line of the township, 25 feet of Chemung gray shaly rock dip steep north.

§ 62. 300 yards below J. Collins', where the creek bends to the north, there are alternations of red and gray shaly rock, the gray predominating. The red bands are 5 feet thick. The dip is sharp to the north. These beds are probably in the same horizon as beds No. 42 to 50 in the Loyalsock section.

A little further down the creek, and at a lower level, 15 feet of Chemung gray shaly rocks are exposed, dipping fast to the north.

§ 63. *Limestone.*—At a school house between Bennett's run and Tule's run, a mile and a quarter east of Montoursville, in Fairfield, limestone is quarried and burned for lime. It is the same bed as that worked between Montoursville and Williamsport.

In the northwest corner of Muncy township, between G. Sweely's and J. Hall's, 15 feet of red shale rocks are exposed, dipping north.

The soil and stones are red at Huntersville, and all the way down Mill creek, to the line between Muncy and Upper Fairfield townships.

At the carpet factory, on the same stream, 5 feet of red shale rocks dip to the north.

§ 64. *Iron ore.*—About one and a quarter miles south of Huntersville, there is a bed of iron ore, from 2 to 3 feet thick, which was formerly worked by the Danville Iron Company. It is the Mansfield iron ore, and is the same as that opened at Cogan station, on the Lycoming creek, and also the same as that occurring in the Loyalsock section.

About three quarters of a mile south of the carpet factory, near E. King's, the soil and stones are gray.

On Carpenter's run, one and a quarter miles north of Pennsville, 10 feet of Chemung gray shale rocks are exposed, having a sharp north dip.

§ 65. *Limestone.*—At H. Ecroyd's and J. Dirn's, one mile E. S. E. from Pennsville, limestone is quarried for the manufacture of lime. It is the same bed as that worked at so many places both above and below Williamsport.

In Wolf township, at the lower end of Villa Grove, Chemung gray shaly rocks dip to the north.

Some 500 yards above the last locality, at the forks of the road, and near a saw-mill, the same kind of rock dips north.

In Shrewsbury township, just below Tivoli, Chemung gray rocks dip to the northward.

Just north of Tivoli there is a bold and inaccessible cliff of red and gray (mostly gray) rocks, 100 feet high and dipping to the northward.

About 1100 yards above Tivoli, on the road up Muncy creek, there is an exposure of some 10 feet of reddish rock in place. It belongs to the Chemung.

Some 300 yards further on, 75 feet of gray and reddish rocks (mostly gray) dip to the northward. They are probably in the Chemung group.

About 600 yards above the mouth of Lake run, near S. Hamman's, a considerable thickness of reddish shale and sandstone is exposed.

Red rock are exposed below E. Lyon's saw-mill, on Muncy creek, about 1100 yards from the county line.

Penn, Moreland, Franklin and Jordan Townships.

§ 66. These are in the extreme southeastern corner of Lycoming county. They lie entirely east of the Susquehanna river and are drained by the waters of Muncy creek and Little Muncy creek.

The centre line of the Tomb's run and Muncy creek anticlinal runs through the north part of Penn township, along Muncy creek, and enters Sullivan county where the creek crosses the county line.

From this line the dip is north to the bottom of the Loyalsock synclinal, and south to the centre line or bottom of the Short mountain, Hepburn and North mountain synclinal.

The centre line of the Short mountain, Hepburn and North mountain synclinal runs through the central part of of Penn township.

§ 67. The *Chemung* and *Catskill* groups make the country rock in these townships.

The *Chemung* is exposed in *Penn* township, along Muncy creek, through a part of its course, and again in the south part of the township.

The balance of Penn township is covered with the Catskill group, in the Short mountain, Hepburn, and North mountain synclinal.

§68. Only *Chemung* rocks were seen in *Moreland* township.

§ 69. The *Catskill* outcrop enters *Franklin* township north of Lairdsville, and runs along Muncy creek, through Jordan, to a point about one mile north from its southeast corner, where it enters Sullivan county.

North of this line the surface rock is Catskill and south of it is the Chemung group so far as examined.

§ 70. There are numerous exposures of parts of the different formation at various places in these townships. These exposures are as follows:

In Penn township, on Sugar run, and near D. Reese's, Chemung gray shales dip to the northward.

One mile east of the last locality the soil and stones are red in color.

One mile north of the last locality, at J. P. Derr's, and all the way to C. R. Simon's, near a school house, the soil and stones are red, derived from the Catskill.

71. *Glacial striæ.*—Near C. McCarty's, in the road, and one mile west of Beaver Dam pond, *glacial scratches* on red sandstone run *north and south.*

§ 72. *A large bowlder* of Pottsville conglomerate here must have been brought several miles from the north, from the Allegheny ridge. Frozen in the bottom of a moving mass of ice it may have been one of the instruments which made the grooves and scratches on the sandstone.

§ 73. *Plications.*—Half a mile northwest from Beaver Dam pond, in the road and near its forks, some curious folds occur in red rocks, the dip being twice reversed in the space of a few rods, being northeast and southwest. On these same rocks the glacial scratches run north and south.

Along the road descending from the last locality to Muncy creek, the soil and stones are red.

§ 74. In Moreland, where Muncy creek leaves it, 30 feet of Chemung gray shaly sandstones are exposed, having apparently an easterly dip.

About three quarters of a mile east of the last locality, near the grist-mill, Chemung gray rocks are exposed, apparently nearly horizontal.

About half a mile northwest of Moreland, near a saw-mill, Chemung gray rocks are in place, and about horizontal.

§ 75. In Franklin township, where Muncy creek leaves it to enter Moreland, Chemung gray shaly rocks dip gently to the northward.

At Lairdsville, Chemung gray rocks are exposed, dipping to the northward. Some red stones have been washed down a little stream coming into the Muncy creek, from the north, at this place.

At Crouse Brothers' saw-mill, a mile above Lairdsville, the soil is red from the decomposition of red rocks.

At P. J. Vandine's saw-mill, at the mouth of Beech Bottom run, 30 feet of red shaly rock dips north.

Half a mile above it, at Crouse Brothers' upper mill, 20 feet of red rocks are exposed.

§ 76. In Jordan township, a little above the mouth of Indian Camp run, where the Muncy creek bends to the south, 25 feet of Chemung gray shaly rocks are exposed, dipping to the northward.

A little further on, where the Muncy creek bends to the north, the north dip brings in the red rocks again.

§ 77. *Fish.*—At Bigger & Camp's saw-mill, a mile above the mouth of Indian Camp run, on Muncy creek, in Jordan township, 10 feet of red shaly rocks are exposed in the road, dipping to the northward. Some of it is filled with fish remains of a *Holoptychian* character, mostly scales and teeth, but generally in a fragmentary condition. It is by far the best locality for this class of fossils as yet seen in Lycoming county. The bed belongs in the Catskill group.

Everywhere along the Sullivan county line, in the north part of Jordan township, and across the end of Franklin township, the soil and rocks are red.

McIntyre, Cascade, Plunkett's Creek, Lewis, Cogan House, Jackson, Pine, Cummings, McHenry, and Brown Townships.

§ 78. This is the mountain region of northern Lycoming stretching from the Tioga county line on the north to the brow of the Allegheny mountain, overlooking the Susquehanna valley on the south.

The centre line of the Blossburg synclinal axis runs across the northwest corner of Brown township from the southwest to the northeast. This is on the supposition that the northwest corner of the township and county is square, cornering between Tioga and Potter counties, as represented in the atlas map of Lycoming county; for the synclinal axis would not enter Lycoming county at all if those maps are correct which give this northwestern corner to Clinton county.

The centre line of the Towanda anticlinal axis enters Brown township at its southwest corner, and running to the northeast, crosses Pine creek at the mouth of Slate run; crosses the township line between Brown and Pine townships at Upper Trout run; and after running through the northwest corner of Pine township, past Oregon hill and Texas P. O., leaves the township and county to enter Tioga where Little Pine creek crosses the county line.

From this line the dip is northerly to the bottom or centre line of the Blossburg synclinal, and southerly to the bottom or centre line of the Barclay and McIntyre synclinal axis.

The centre line of the Barclay and McIntyre synclinal axis comes up from the southwest out of Clinton county; crosses Pine creek about one and a half miles above Campbelltown, in McHenry township; leaves McHenry township to enter Pine township about one and a half miles south from the northeast corner of McHenry township; crosses Little Pine creek about one and a half miles above the mouth of Blockhouse fork; leaves Pine township to enter Jackson township about three miles south from the northeast corner of Pine township; crosses the Blockhouse fork about one mile below Buttonwood P. O.; leaves Jackson township to enter McIntyre township about three miles south from the northeast corner of Jackson township; crosses Lycoming creek near the mouth of Dutchman's run, at McIntyre; leaves McIntyre township to enter Sullivan county about three fourths of a mile south from the northeast corner of the township; runs across the corner of Sullivan county and on to Barclay and beyond, in Bradford county.

§ 82. Cogan House and Jersey Mills anticlinal axis. The centre line enters Lycoming county from Clinton county, near Haneyville P. O.; crosses Pine creek about one mile above Jersey Mills P. O., in McHenry township; leaves McHenry township to enter Cummings township about two and a half miles south from the northwest corner of Cummings township; crosses Little Pine creek near the mouth of Carson run; leaves Cummings township to enter Pine township where Carson run crosses the township line; leaves Pine township to enter Cogan House township about half a mile north from its south or southeast corner; leaves Cogan House township to enter McIntyre township at the southwest corner of McIntyre township; and after running about a mile and a half into McIntyre township, across the old Liberty and Trout run road, it suddonly subsides, and is not traceable further to the northeast.

From this line the dip is north to the bottom of the Barclay and McIntyre synclinal axis, and south to the bottom of the Waterville, Loyalsock and Bernice synclinal axis.

§ 83. Rose valley anticlinal. The centre line runs northeast from Rose Valley P. O., in Lewis township; leaves Lewis township to enter Cascade township about 4 miles north from the southwest corner of Cascade township; leaves Cascade township to enter Plunkett's Creek township about three fourths of a mile south from the northwest corner of Plunkett's Creek township; leaves Plunkett's Creek township and Lycoming county to enter Sullivan county about half a mile south from the northeast corner of Plunkett's Creek township. The anticlinal axis soon subsides after entering Sullivan county, in the vicinity of Hillsgrove.

From this line the dip is north to the bottom of the Barclay and McIntyre synclinal axis, and south to the bottom of the Loyalsock synclinal axis.

§ 84. Waterville, Loyalsock and Bernice synclinal axis.

The centre line comes up from the southwest out of Clinton county; crosses Pine creek about one mile above Waterville and the same distance above the mouth of Little Pine creek, in Cummings township; leaves Cummings township to enter Mifflin township about one mile south from the northwest corner of Mifflin township; crosses the Second fork of Larry's creek near the mouth of Francis run; leaves Mifflin township to enter Cogan House township near the northeast corner of Mifflin township, where it crosses Larry's creek; leaves Cogan House township to enter Lewis township about one mile north from the southwest corner of Lewis township; crosses Lycoming creek about half a mile above Crescent station; leaves Lewis township to enter Cascade township near the southwest corner of Cascade township; leaves Cascade township to enter Plunkett's Creek township, at the southeast corner of Cascade township; and leaves Plunkett's Creek township and Lycoming county to enter Sullivan county where the Loyalsock creek crosses the county line.

§ 85. The surface of these northern townships is mountainous, the only exception being in the anticlinal valleys of Cogan House and Rose Valley, where there are narrow belts of two or three miles in width and from twelve to sixteen miles in length, over which the surface is rolling and occasionally hilly.

§ 86. The surface in McIntyre, Cascade, Plunkett's Creek, Lewis, Cogan House, Jackson, Pine, Cummings, McHenry and Brown townships is made by the Catskill, Pocono, Mauch Chunk, Pottsville and Coal Measures.

The *Catskill* comes to the surface in the valleys of all the streams; also in the two anticlinal valleys of Cogan House and Rose Valley. For the limits of the formation see the colored county map appended to this Report.

The Catskill rocks are composed principally of red shale and sandstone, but with some beds of gray shale and sandstone. They are eight hundred feet thick in the northern part of the county and from one thousand to fifteen hundred feet thick in the southern part.

The *Pocono* rocks overlie the Catskill, and make up the great mass of the mountains all through this region. The limits of this formation are shown on the colored county map.

The Pocono rocks are largely made up of coarse gray flaggy sandstones. These sandstones are nearly always current-bedded: are frequently micaceous: and sometimes are greenish in color and frequently greenish gray.

The *Mauch Chunk* rocks overlie the *Pocono* and are found near the mountain crests in some parts of the synclinal basins.

The massive *Pottsville Conglomerate of XII*, and the overlying *Lower Productive Coal Measures* cover only a moderate area in these townships. These areas are described in detail in the chapter devoted to the Coal basins of Lycoming county.

The conglomerate of XII is a coarse white quartzose sandrock, which in some places is filled with pebbles of quartz. This massive pebble rock is one hundred and twenty feet thick in Plunkett's Creek township, if we leave out the two hundred feet and more of brownish rock with which it is overlaid. It is probably much thinner in the northern part of the county.

§ 87. There are numerous exposures of parts of the different rock groups in different places in these townships.

These exposures are as follows:

In *McIntyre* township, all along the railroad from Roaring Branch to Carpenter's station, near the Bradford county line, and rocks, belonging to the Catskill, dip rapidly to the southward.

At the confluence of the Lycoming creek and Roaring Branch, the same kind of red shaly rock dips also to the south.

About one mile below Roaring Branch P. O., on Lycoming creek, the top of the Catskill group disappears beneath the bed of Lycoming creek, owing to this rapid south dip and is succeeded by the Pocono group. At this place also we see the first *bowlders* of Pottsville Conglomerate of XII slowly making their way down the mountain side and scattered over the valley.

A short distance further down the stream, where the road crosses the creek, gray diagonally laminated sandstones, belonging to the Pocono formation, dip to the north.

Half way between Abbott's run and Dutchman's run, at J. Dougherty's, 40 feet of gray diagonally laminated sandstone, belonging to the Pocono, is exposed, dipping very slightly to the southward, and containing a few *plant remains.*

A little below McIntyre station, on the Northern Central railroad, on the west side of Lycoming creek, some 30 feet of rocks, similar to the last named, and belonging to the same formation, are exposed lying in place, and dipping gently to the northward.

Back of the Ralston hotel (Meyer's), opposite the mouth of Rock run, 60 feet of gray diagonally laminated sandstone are exposed, belonging also to the Pocono and dipping gently to the north. These rocks are underlaid by 2 or 3 feet of impure rough looking *calcareous* rock, which in turn is underlaid by 15 feet of red shale, which is probably the top of the Catskill group.

At the saw-mill, just below the mouth of Frozen run, 8 feet of red rocks are exposed, belonging to the Catskill and dipping gently to the north.

The soil in the valley at the mouth of Pleasant stream is also red colored from the decomposition of the same kind of rock.

§ 88. In *Cascade* township, where the road from Bodinesville to Kellysburg leaves Slack's run, 10 feet of red sandstone rocks are exposed, belonging to the Catskill. Dip not seen.

At the forks of the same road, on the hill west of Salt run, 15 feet of red shales and sandstones are exposed, belonging to the same formation. Dip unknown.

At Corcoran & Weaver's mill, where the road crosses the East Fork of Salt run, red rocks belonging to the same formation dip to the north.

At Kellysburg, 12 feet of red sandstone rocks are exposed, belonging to the Catskill group, and dipping to the northward.

§ 89. In *Plunkett's Creek* township, just below Proctorville, where the road crosses Plunkett's creek, 10 feet of red shale rocks are exposed, overlaid by 10 feet of red sandstone; they belong to the Catskill group and are dipping rapidly to the south.

At Storr's dam, below Proctorville, the topmost bed of the Catskill group disappears beneath the bed of the creek, owing to the rapid south dip.

At the mouth of Plunkett's creek, 40 feet of gray diagonally laminated rocks are exposed, belonging to the Pocono group of rocks, and dipping gently to the southward.

At Barbour's Mills P. O. and along Big Bear Creek there are great numbers of *bowlders* of the Pottsville Conglomerate of XII, come down from the crest of the hills above.

On Big Bear Creek, between two saw-mills, and about two thirds of a mile from Barbour's Mills P. O., 6 feet of red shale rocks are exposed, overlaid by 6 feet of gray shale, which in turn is overlaid by gray sandstone. The dip is gently to the north, and the beds belong most probably to the Pocono group.

At the upper one of the two saw-mills last named, opposite to the mouth of Snake run, great quantities of massive *bowlders* of the Pottsville Conglomerate of XII have rolled down from the crest of the hills above.

Between the mouth of Snake run and Shingle run, on Big Bear creek, 20 feet of gray sandstone rocks are exposed, belonging probably to the Pocono group.

Between the mouth of Shingle run and Rock run, on Big Bear creek, and back of S. Campbell's, 120 feet of coarse white sandstone, the Pottsville Conglomerate of XII, are exposed high up the side of the mountain, *overlaid* by 200 feet of brownish sandstone, and underlaid by black and dark colored slate with traces of *coal*, roots of *Sigillaria* and other Coal *plants*.

In the horizon of the black and dark colored slate, at other points in the mountains, Mr. Campbell *reports* that he has found a *bed of coal* eighteen inches thick.

In the south corner of the township, where the road goes down the mountain, red shale is exposed belonging to the Catskill.

§ 90. In *Lewis* township, where the road up Lycoming creek crosses the Lewis-McIntyre township line, 12 feet of red shaly rocks are exposed, belonging to the Catskill group, and lying nearly horizontal, though appearing to dip slightly to the north.

About half a mile above Bodinesville along the road on the west side of Lycoming creek, 10 feet of red rocks, similar to the last, and belonging to the same formation are exposed, lying in place, and nearly horizontal.

Across the creek from Field's station (on the Northern Central railroad), on the main road, 25 feet of red shale and sandstone rocks are exposed, belonging to the Catskill group of rocks, and lying nearly horizontal.

Along Trout run, on lands of A. S. Turner, there are considerable quantities of *bowlders* of the Pottsville Conglomerate of XII, derived from the surrounding mountains.

Just below Trout Run P. O., near Turner's planing-mill, a mass of red shaly rock, belonging to the Catskill group, appears to dip slightly to the north.

About one mile southwest from Rose Valley P. O., near J. Stroble's, 5 feet of Catskill sandstone rocks are exposed, the dip not visible.

About one mile further in the same direction, near J. Young's, a like thickness of the same kind of rock is again exposed, dipping to the south.

§ 91. In *Cogan House* township, about one and a quarter miles southwest of White Pine, 10 feet of reddish shaly sandstones are exposed, belonging to the Catskill group and dipping to the north.

At White Pine, Cogan House and Steam Valley, the soil and stones are red, derived from the Catskill rocks.

§ 92. In *Jackson* township, 2 miles southeast of Buttonwood P. O., where the road goes over the mountain, there are numerous loose masses of the Pottsville Conglomerate of XII all over the surface in great *bowlders*.

One and a half miles east of Buttonwood P. O., at the foot of the mountain, red and gray sandstones are exposed in place, belonging to the Catskill rocks, and dipping to the south.

Half a mile north of Buttonwood P. O., reddish sandstone, belonging to the Catskill group, appears to dip to the southwest. The same bed contains *glacial scratches* running apparently northwest and southeast.

A mile north of Buttonwood P. O., at a grist and sawmill, red and gray sandstones are exposed, belonging to the Catskill group and dipping to the southwest.

§ 92. In *Pine* township, one fourth of a mile north of Texas P. O., red shale rocks are exposed, belonging to the Catskill group.

Between the mouth of Rock run and Wolf run, on Little Pine creek, gray sandstone is exposed, belonging to the Pocono group of rocks.

At the same place there are great masses and *bowlders* of the Pottsville Conglomerate of XII, which has come down from near the crest of the hills above.

§ 94. *Section 7, Fig. 10.*—Half way between Bear run and the Blockhouse fork, above D. M. Arrowsmith's house, the following are exposed in place, belonging to the Catskill group, and having considerable dip to the northward.

Top of Section.	
1. Red and gray sandstone,	20′
2. Red shale,	10′
3. Light gray and bluish shale, with *carbonized plant stems*, and some thin *seams of coal* one inch thick,	10′
4. Red shale and sandstone,	20′
5. Bluish shale,	2′
6. Red sandstone,	12′
7. Red shale, with streaks of greenish shale,	10′
Total,	84′

Below the mouth of Bonnell run, and above English Centre, 50 feet of red shales and red and gray sandstones are exposed, belong to the Catskill group, and dipping to the northward.

Just below English Centre and a little below the mouth of

Pine run, 10 feet of gray sandstones are exposed, belonging to the same formation.

Near the mouth of Otter run, at Otter Run P. O., 6 feet of gray sandstones are exposed, belonging also to the Catskill group, and dipping to the northward.

The indications would seem to warrant a belief in the presence of considerable *coal* in Pine township, on Rock run, Four Mile run, Pine run, Otter run, &c., &c.

§ 95. *Section 8, Fig. 11.*—In *Cummings* township, below the mouth of Ramsay's run, in the East bend of Pine creek, and about half a mile from the Watson township line, the following beds are exposed, belonging to the Catskill group, and dipping gently to the north:

1. Red shaly sandstone,	10′
2. *Calcareous rock*, impure,	1′ 6″
3. Red shale,	15′
4. Gray sandstone, one large piece covered with *fish bones* .	10
Total,	36′ 6″

In passing up Pine creek the first exposure of great masses and loose *bowlders* of the Pottsville Conglomerate of XII is at the mouth of Ramsay's run.

About three fourths of a mile below Waterville, on the east side of Pine creek, 40 feet of red shales are exposed in place, belonging to the Catskill group, and lying nearly horizontal.

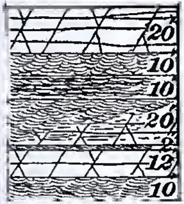
§ 96. *Section 9, Fig. 12.*—At Waterville the following beds are exposed, belonging to the Catskill, and dipping slightly to the north.

1. Soft red shale, (*top of section,*)	25′
2. Gray sandstone,	30′
3. Red shale,	20′
4. Gray sandstone,	15′
Total,	90′

About one mile above Waterville, on the east side of Pine creek, and between the upper and lower Pine Bottom runs, 20 feet of red and gray shale rocks are exposed, belonging to the Catskill group.

About three fourths of a mile above Waterville, on Little

Sec. 7. Fig. 10.



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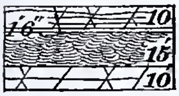
Catskill rocks in Pine township.

Red and gray sandstone.
Red shale
Gray shale with Coal Plants and Coal.
Red sandstone and shale.
Blue shale.
Red sandstone.
Red shale.

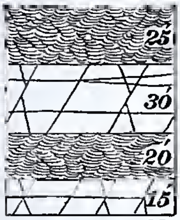
Sec. 8. Fig. 11.



Catskill rocks in Cummings township.

Red shale.
Calcareous layer.
Red shale.
Gray sandstone, with Fish remains.

Sec. 9. Fig. 12.



page 66.

Catskill rocks at Waterville.

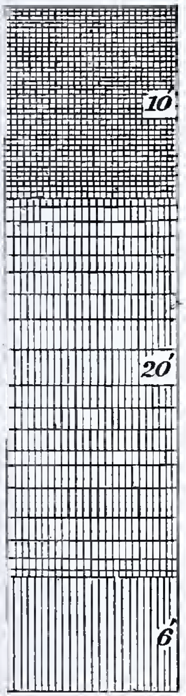
Red shale.

Gray sandstone.

Red shale.

Gray sandstone.

Sec. 10. Fig. 13.



page 77. CC.

"Black marble quarry" Mosquito Valley

Limestone in layers of one to two inches.

Limestone in beds one or two feet thick.

One massive bed of Limestone.

Pine creek, 25 feet of soft red shales are exposed, belonging also to the Catskill group.

Half a mile below English Mills P. O., on Little Pine creek, there are numerous *bowlders* of the Pottsville Conglomerate of XII, brought down from the hills in the coal basin.

One mile above English Mills P. O., at John H. Nabal's, gray sandstone rocks are exposed, belonging probably to the Catskill group.

One and a quarter miles above the last named locality, near H. Beach's, 10 feet of red sandstones are exposed, belonging to the same formation.

A little above the mouth of Carson run, on the west side of Little Pine creek, and near the township line between Cummings and Pine townships, 5 feet of red shale rocks are exposed, belonging also to the Catskill.

§ 96. In *McHenry* township, a little above the mouth of Harris run, and about one mile below Jersey Mills P. O., there are numerous *bowlders* of the Pottsville Conglomerate of XII, derived from the hills in the coal basin.

A little above the last locality, in the east bank of Pine creek, and about three fourths of a mile below Jersey Mills, the soil and stones are red, derived probably from the Catskill group.

About one mile above Jersey Mills, opposite J. Ross', and some 50 feet above the bed of Pine creek, 20 feet of red shales and sandstones are exposed, belonging to the Catskill group, and lying apparently nearly horizontal.

Between Miller's run and School House run, and about half way between Jersey Mills and Campbelltown, 20 feet of gray sandstones are exposed in place, belonging most likely to the Catskill group, and dipping apparently very slightly to the northward.

About one mile below Campbelltown, in the east bank of Pine creek, between Trout run and Salmon run, gray sandstones crop out in place, belonging most probably to the Catskill group. The dip and thickness of the rocks could not be seen.

At Campbelltown, around the mouth of Mill run, red shales and gray sandstones are exposed, belonging probably to the Catskill group. The dip and thickness do not show.

At the mouth of Wolf run, about three miles above Campbelltown, 40 feet of red shales and sandstones are exposed, belonging to the Catskill group. The dip does not show.

Future investigations may reveal the presence of much *coal* in McHenry township.

§ 98. In *Brown* township, on Pine creek, at the line between Brown and McHenry townships, the dip is south.

Opposite the mouth of Tomb's run, on the west side of Pine creek, red rocks are exposed, belonging also to the Catskill; they appear to dip slightly to the north.

At A. Hostrander's, half way between Miller's run and Gamble run, there are numerous loose *bowlders* of the Pottsville Conglomerate of XII, evidently from the mountains to the north and west.

Another locality of *bowlders of XII*, like the last named, occurs between Gamble's run and Cedar run, opposite the mouth of Jacob's run.

At the mouth of Cedar run, red rocks, belonging to the Catskill group, dip to the northward. This is a fine exposure for obtaining a vertical section.

About half a mile above Cedar run, red rocks, belonging to the same formation, dip to the northward.

About one and a half miles below Lloyd's hotel, 200 feet of red and gray rocks, belonging also to the Catskill group, dip gently to the northward. It is a fine exposure.

Where the road goes up the mountain from the mouth of Slate run to the old Jersey Shore and Coudersport turnpike, about one and a half miles from Pine creek, there is a vein of Mauch Chunk *iron ore* (ore of XI) which was opened many years ago. The thickness is unknown.

At Samuel Herrit's, on the old Jersey Shore and Coudersport turnpike, there is a bed of *coal* two feet thick.

Longitudinal Sections
to illustrate
the geology of Lycoming county, Pennsylvania.
Report of Progress GG. 1880. page 70.

Fig. 14.

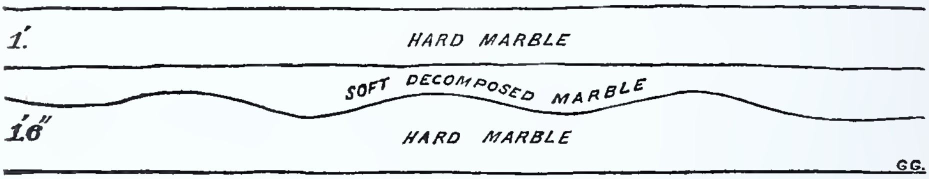


Fig. 15.
Section at East end of Bridge over Susquehanna River, in road from Antesport to Jersey Shore.

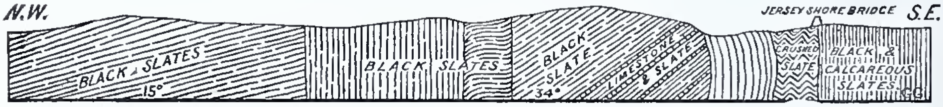


Fig. 16.

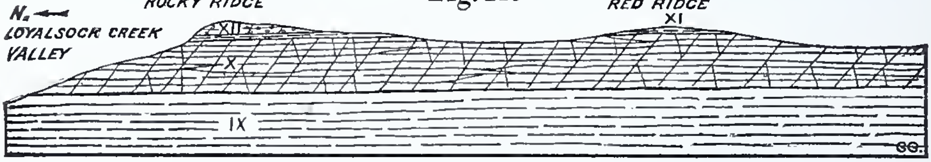
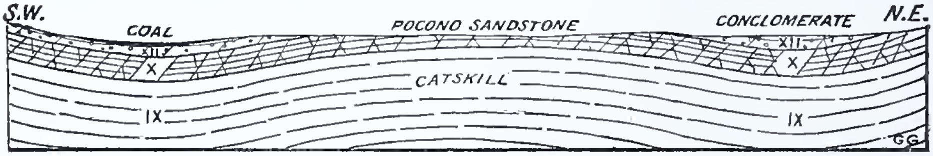


Fig. 17.
Section lengthwise of the Little Pine creek Coal Basin.



CHAPTER III.

Details of the Southern Townships.*

Clinton Township.

§ 99. The colored map shows the mountain of IV, (the Bald Eagle,) rounding off in this township, the Susquehanna river winding around the end of the mountain. Formation V is the country rock on the north side of the mountain from the crest, to and beyond the river: formation VI crosses the river from Muncy Creek township and then runs west up White Deer valley, parallel to Bald Eagle mountain: formations VII and VIII come in and make the rocks of the southern part of the township.

Formation IV is partially exposed in this township on the turnpike road from Montgomery station to Williamsport, across the Bald Eagle mountain. Both crests of IV, the upper and lower sandstones, are deeply cut out, and the summit in this notch is in the middle of IV, just beyond the toll-gate. This crest is only some 1325 feet above the ocean. The exposures are not sufficient to afford a complete measurement of IV.

Formation V covers a considerable part of Clinton township, yet it affords very few exposures, and those disconnected. In the White Deer Valley it spreads out broadly from the mountains, as the dip is gradually lessening towards the centre of the synclinal axis, and it underlies some good farms lying towards the foot hills of Bald Eagle mountain.

§ 100. *Fossil iron ores of V.*—No persistent and intelligent attempt has been made to mine this ore in Clinton. Should these ores ever be found in this township of good size and character they would have a run along the mountain for many miles. But the face of Bald Eagle mountain is covered so deeply with sandstone bowlders from its crest as to make the search for this fossil ore an expensive operation, more so than the character of the ore as opened at other places along the mountain has hitherto justified.

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* By Franklin Platt.

Formation VI has only been opened in one place in Clinton township, at the Groff school house one half mile north of Clintonville. It dips to the southward 12°±. The quarry was opened originally to get stone for bridge building.

There is so much loose débris here over the limestone that it does not pay to do the necessary stripping to secure the stone for lime burning purposes. The limestone at the quarry is siliceous in character. This heavy mass of loose wash over Formation VI in Clinton township renders it less certain in location than in Washington and Brady townships where it can be followed along a straight and continuous ridge; but the colored line of VI on the map cannot be far from correct.

Formation VII does not show in Clinton township unless some few loose pieces of flint rock represent it.

Formation VIII comes in over the limestone and makes the country rock of the southern part of the township. The rocks are gray and blackish gray slates: they weather easily and make a fairly good soil. As is usual however with the slates of VIII they make gently sloping rounded small hills and present no striking features of topography; and they yield in southern Lycoming county nothing which is available for mining.

Brady Township.

§ 101. *Formation V* covers only the extreme northwest corner of Brady township.

Formation VI, the Lower Helderberg limestone has once been opened in a quarry in the northwestern part of the township but is not now worked.

Formation VII, the Oriskany sandstone, is either entirely lacking or is represented by a flint rock only a few feet thick.

Formation VIII (the Hamilton group) covers the rest of the township. It is made up of gray and grayish black slates, usually soft and easily disintegrated, and making low smooth round hills fertile and well cultivated.

Washington Township.

§ 102. This is a very large township, 11 miles in length by 5 miles in width: it takes in the greater part of the White Deer valley.

Formation IV, as the White Deer ridge, bounds this township on the south and west: and the same formation, as the Bald Eagle mountain, bounds it on the north.

These are high mountains; Bald Eagle mountain, on the road from Elimsport to Williamsport, rising to fully 1900 feet above the sea level. Both are double crested, the upper and lower members of IV making distinct crests, separated by the thickness of the middle member of IV.

These crests surround the valley in regular and sweeping curves and make an exceedingly symmetrical and handsome synclinal valley.

Formation V, the Clinton group, covers a large part of Washington township. The dip from the mountains into the valley is not steep and the Clinton group therefore spreads over a broad area, circling around on the inside of the mountains, and covering nearly all of the western part of the township.

§ 103. Great masses of sandstone bowlders falling down from the mountain crests of IV have prevented almost entirely any examination for the *fossil ores of V*. One attempt to open some iron ore on the flank of Bald Eagle mountain, near the north line of Washington township, was abandoned after reaching a small loose show of pieces of sandy limonite ore.

The part of the valley underlaid by Formation V is tilled and makes good farms: the part on the mountain flank is covered by loose débris and useless for farming purposes.

Formation VI, the Lower Helderberg limestone, as is shown by the colored county map, sweeps around the valley, parallel to the mountains, but round off and returns again to the eastward before reaching Elimsport.

There is no opportunity to make an exact measurement of the thickness of the Lower Helderberg limestone in Washington township, but it appears to be over 200 feet in all, including slate layers.

§ 104. Quarries are opened and worked on the lower layers of the *limestone*, and considerable lime is burned for agricultural purposes.

At the Peter Buck quarry, one and a half miles northeast of Elimsport, the quarry face shows some 35 feet of blue limestone, the several layers ranging in thickness from one inch up to two feet thick. The limestone is all burned as quarried and makes good agricultural lime. The dip of the limestone in the quarry is south 20° east, 15°.

Just southwest of this quarry the limestone ridge points up, and marks the end of VI in the White Deer valley.

At another quarry on this limestone, along the same ridge, and two miles east of the Buck quarry, there are exposed 30 feet of massive blue limestone. It burns to good lime for agricultural uses. The dip at this quarry is south 10° to 15° east, 16°.

The same limestone has been opened on the south side of the valley, near the Haines grist-mill. It is there dipping back to the north and west.

These quarries and kilns are run sufficiently to supply the local demand of the farmers of the upper part of White Deer valley.

No fossils were found at any of the exposures.

Formation VII, if it exists at all in Washington township, must be very thin and insignificant. The ridge in which the limestone is quarried gives a fair though not complete section of the rocks from VI up to VIII: and the only trace of VII is that near the junction of VI and VIII there are pieces of hard flinty sandstone scattered on the surface which may mark the presence of the Oriskany sandstone in place as a small layer. For wherever this hard flinty sandstone is 50 feet thick, as in Blair county, it forms a prominent feature in the topography, always making the crest of a decided ridge, with the limestone of VI falling off steeply on one side and the soft slates of VIII sloping away on the other.

Formation VIII covers a small part of Washington township, at the eastern end. The rocks which compose it are usually gray and black slates, very soft and easily disintegrated: but little undecomposed rock is to be seen in the cuts on the road side. The portion of the township underlaid by VIII is all under cultivation and has fertile and productive farms.

Armstrong Township.

§105. This township has the Susquehanna river for its north boundary line, and the high mountain ridge (where it joins Washington township) three miles south of the river, as its south boundary. Its length along the river is about 8 miles.

The township presents some beautiful geology. Nearly the whole eastern end is a great mass of mountain of IV, where the huge anticlinal axis, entirely arched over with the rocks of IV, is dying away to the eastward. The upper and lower members of IV here show, as always, a sharp crest, covered over with massive sandstone pieces; but where the middle of IV arches over nearly or entirely horizontal, the softer red rocks have made a soil, and some rugged farms are perched in the hollows of the high plateau.

In the western part of the township the anticlinal is eroded at the centre of the arch and the little oval Mosquito valley shows fertile and cultivated soft hill slopes and flats of the shales and slates of III, so entirely surrounded by rugged mountains as to be invisible until the narrow gorge in IV is passed, through which the drainage of the valley issues. This stream is utilized for the water supply of Williamsport.

Formation V covers all that part of Armstrong township between the river on the north and the first crest of the Bald Eagle mountain to the south. As usual, there is but little exposure of the rocks of the Clinton group in place: none at all along the the mountain slope, or on the flats, but a few in the gaps by which the drainage of Mosquito valley comes out of the mountain, and on Rock run.

On Mosquito Valley creek the red sandstones and slates of V are vertical: and on Rock run they dip about 75° to the northward.

At the southern end of Rocktown, and just south of Duboistown, a small siliceous limestone, about 10 feet thick has been opened. It is one of the small worthless, limestones of V.

The fossil ores of V have not been opened at all along the mountain face of Armstrong township. Their run along the crop would be for 8 miles.

Formation IV covers the largest part of Armstrong township.

The main road across to White Deer valley, which follows up Rock run, cuts nearly through the measures of IV, showing at first (in the north Bald Eagle mountain) 75°, N. dipping red sandstones of V (Clinton); then the dip decreasing to 40°, in gray sandstones of the Upper division of IV (Medina *white*); to 20°, to 10°, to 5°, in the red sandstones of the middle of IV (Medina *red*), and finally to 0° in gray sandstones of the Lower of IV (Oneida) at the centre line of the anticlinal arch. These exposures are not sufficiently connected, nor on a sufficiently accurate map, to make a perfect measurement for thickness possible.

On the toll road across from Williamsport to Clinton township, the upper sandstone of IV shows, dipping north 36°. The middle of IV is exposed for a very long distance, but imperfectly, and much covered over by débris.

On the Mosquito valley creek road the exposures of IV are numerous. South of Duboistown both V and IV are vertical. The road forks south of Duboistown, and the west fork (leading to Nippenose valley) runs up a branch of Mosquito valley run, keeping in the middle of IV. Near the head waters of this branch, on a plateau of red rocks of IV, several farms have been cleared and are now cultivated. The road keeps in IV to the township line.

The road following the main branch of Musquito valley run, enters Mosquito valley through an abrupt gorge in IV, runs along the valley, passes out from it on the south side by another steep gorge in IV, and then keeps in IV all the way to the township line. Of all this great area of IV, the soil is for the most part unavailable for agriculture and the timber is of small value. Some excellent quarries of *building stone* have been opened and the mountain can afford an indefinite amount of good building material.

Formation III covers most of that part of the western end of Armstrong known as Mosquito valley. This valley is deeply scooped out along the axis of the anticlinal arch, the level of the centre of the valley being only 800 feet above the sea level, the enclosing mountains rising some 800 to 900 feet above it. The soil is smooth and fertile, being all cultivated up to the foot of the mountains, the débris from the mountain top having covered the mountain slope with masses of loose sandstone.

Formation II covers a small area of Mosquito valley, just on the very crest of the anticlinal arch.

§ 106. This identification of II was made with much hesitation and doubt.

The measures at the bottom of formation III are *calcareous black slates*, and rocks of the same character go to make up the upper part of II. It is always difficult therefore to mark the junction plane of II and III. In this case however Mr. C. E. Hall recognizes a fossil trilobite from Mosquito valley as *Calymene senaria* and undoubtedly Trenton. So Formation II is made on the map to cover the centre of the anticlinal.

§ 107. *Black marble quarry.*—Near the east end of the valley the Mosquito valley a *marble quarry* has been opened. It yielded the fossil named above.

The rock is a black limestone; quarries out in large blocks and takes a handsome polish. It is reported however not to stand exposure, but splinters up on weathering. This would render it useless for any outside work, but might still leave it of value for inside decorations.

When the quarry was examined (in 1875,) the works were in operation: they had 1 gangsaw, capacity 100 tiles per diem: these tiles usually 12″×12″×1″: the tiles going to Philadelphia and the stone to Philadelphia or Washington.

All of the marble is dark colored, very slightly fossiliferous, regular in bedding and works easily. The quarry face is shown in Sec. 10, Fig. 13, (page 67 above.)

Surface bench, in small layers, 1′ to 2′′ and up to 1, . . .	10′ 0″
Middle bench, in regular layers from 2′ to 1′ thick, ...	20 0
Lower bench, massive and hard, but no stone from it yet shipped, ...	6 –
Total, ...	36 0

The dip of these rocks is north, 4° ; the quarry is about on the crest of the anticlinal, and the dip is simply the dying gently of that anticlinal northeastward.

Of the above 36 feet of black marble much proved shelly on quarrying, and split into pieces ; a considerable part however coming out in handsome blocks.

It is reported to burn to an excellent white lime.

There are some curious soft and rotten layers of stone lying between the firm and hard marble layers thus :

Hard marble, ...	1 ′
Soft decomposed marble, ...	—
Hard marble, ...	1½′

the underlying and overlying hard rocks being perfect and unbroken so far as traced. Fig. 14, (see page 67 above.)

Bastress Township.

§ 108. This township lies west of Armstrong.

Formation IV covers the greater part of it. The road from Williamsport to Bastress is in IV on the eastern edge of the township, and the crest of the mountain is there about 1700 feet above the sea.

The road from Bastress P. O. northward to Nesbit P. O. crosses over the Bald Eagle mountain on a low crest : near the north line of the township the upper gray sandstone of IV is exposed in place dipping to the north 40°. The exposures are not such as to add anything to the knowledge of IV already obtained in the previous townships. There is quite an area in northern Bastress where the soft red rocks of the middle of IV make a smooth plateau, high up in the mountain, and several farms are cleared and cultivated upon it.

Formation III is the country rock on the south line of Bastress township, as this makes the northern part of the Nippenose valley. There is little rock in place exposed: the region covered by III is chiefly cultivated farm land, except on the mountain slope. It only takes in part of III, not reaching to the bottom of it, and affords no measurements.

Susquehanna Township.

§ 109. This township lies north of Bastress: and its north boundary is the Susquehanna river.

Formation VI, the Lower Helderberg Limestone, may possibly touch the extreme north border of Susquehanna township. If so it passes under the river flat, deeply covered with the river deposit.

Formation V covers the greater part of the township. No fossil ore is opened along the mountain and the exposures of any rock at all in V are very scarce. They add nothing to our knowledge of V.

Formation IV makes the Bald Eagle crest which runs across the township from east to west. It presents no features other than those already given.

Limestone Township.

This township is bounded on the north by Bastress and Nippenose, on the southeast by Washington, on the east by Armstrong and on the west and southwest by Clinton county.

Nearly all of the Nippenose valley is in this township; the southwest end of the valley, however, lying in Clinton Clinton county and the north part of the valley lying in Bastress township.

The valley itself represents a great anticlinal axis, deeply eroded on the centre of the arch; for the centre of the valley is only some 800 feet above the sea level, while the enclosing mountains are from 800 to 900 feet higher.

It is a perfect picture of an anticlinal valley, oval in shape, entirely surrounded by mountains, and with no outlet save the narrow gorge in IV which lets out the valley drainage. The farms in the valley are fertile and highly cultivated; and the scene presented by this smiling valley, so thoroughly tilled, surrounded by rugged enclosing mountains, is one of a natural beauty not surpassed in the State.

§ 111. The colored map of the county shows the geological formations making the country rock.

Formation IV occupies the southern part and eastern end of the township. There are some exposures of the middle of IV in the southeastern end of the township where there are numerous farms located where red rocks of IV are the country rock. The stream which heads up in this southeastern corner makes a clean cut through the lower of IV by a narrow gorge; the stream sinks near Collomsville shortly after reaching the limestone of II.

Formation III, the Hudson river slates, occupy a large area in the township. They offer few exposures of rock in place. Except on the mountain slope, their area is generally cultivated farms. These add no new feature to those already described.

Formation II, the Siluro-Cambrian limestone, is exposed in part in Limestone township. Only the upper part of the formation is brought up by the anticlinal axis, not more than 1000 feet of the whole formation.

The limestones of II in the Nippenose valley are the ordinary grey and blue limestones and dolomites intermingled, found in Morrison's cove in Blair county, Nittanny valley in Centre county, &c. Many of the layers make an excellent lime for agricultural purposes.

§ 112. In the southwest part of the Nippenose valley, just across the Lycoming county line and therefore in Clinton county, a so-called *plaster* is opened on the Joseph Wilsham place.

The rock dips to the northward 7° or 8°, and in appearance is a bluish limestone, with much calcite, and very fossiliferous in layers.

This rock has been ground up and used as a plaster, and indeed is now used for that purpose. It sells readily to the county around, in considerable quantities, at prices but little below the Cayuga or Nova Scotia plaster. Mr. Metzger and others have a mill near the quarry.

A specimen of the "plaster" rock and of the ground "plaster" were forwarded to the Laboratory of the Survey, and on analysis were found to have less than one per cent. of soluble sulphate of lime. (A. S. McCreath):

Silicic acid,	2.660
Carbonate of lime,	95.071
Carbonate of magnesia,	1.044
Carbonate of manganese,	trace.
Phosphate of lime	trace.
Carbonate of iron,	.261
Sulphate of lime,	.744
Organic matter and water,	.220
	100.000

Geologically the horizon of this so-called plaster rock is about 500 feet ± below the bottom of the slates of III.

The analysis shows that the rock is in no sense a plaster rock, but simply a limestone. Plaster is a hydrated sulphate of lime; that quarried near Montreal, Canada, being made up as follows:

Sulphuric acid,	46.44
Carbonic acid,	.47
Lime,	32.58
Silica,	.11
Water,	20.43
	100.03

§ 113. *Iron Ore.*—That so little of Formation II is exposed in Nippenose valley is probably the explanation of the fact that no limonite or brown hematite iron ore is to be seen in any quantity there.

§ 114. *Nickel.*—Near Rauch's mills at the southwest end of Nippenose valley across the county line, and therefore in Clinton county, there has been considerable mining on the black slates of III for what is called a "nickel ore."

The shaft is down to a depth of some 30 or 45 feet. The rock is a dark colored carbonated clay slate, slightly fossiliferous, occasionally seamed with calcite and carrying iron pyrites. The geological horizon is in III and apparently some 600 feet below the bottom of IV.

An average specimen of the "ore" was forwarded to the Laboratory and described by Mr. McCreath thus:

"The 'nickel ore' is a black siliceous limestone carrying considerable carbonaceous matter, streaked with pyrites, but containing *no nickel.* It shows a mere trace of cobalt."

Nippenose Township.

§ 115. This township lies north of Limestone township and the Susquehanna river makes its north boundary.

Formation IV covers the whole southern part of the township. The upper and lower of IV makes their usual distinct crests. The middle of IV makes a deeply eroded valley along Morgan valley run, heading up on a plateau sufficiently smooth, to be cleared and cultivated.

Formation V, the Clinton Group, spreads out from the mountain crest northward to the river flats. In the Nippenose creek gap the gray and reddish slates of V dip north 10° west, 51°. Northward of these exposures everything is covered deep with wash from the mountain. The railroad cut just west of Jersey Shore station on the Philadelphia and Erie railroad (Antesport P. O.) is 50 feet deep, entirely through loose wash, without touching any solid rock.

§ 116. The fossil iron ore opened and worked on the flank of the mountain, in the western part of Nippenose township, is described in detail in the chapter relating to those ores.

Formations VI, VII and VIII come in to the north of V and cover the balance of the township; but it is difficult in this case to draw in their lines of crop with sufficient accuracy. The heavy wash from the mountain and the débris of the river flat cover up exposures of rock in place.

There are however two exposures of rock which suffice to give the outcrop lines in a general way.

§ 117. Just south of Fort Antes, on the east bank of the Susquehanna, there is an exposure of black slate in place, striking parallel to Bald Eagle mountain, not merely vertical but dipping back towards the mountain (to the south-south east) 76°. These rocks are much contorted. A small show of pieces of flinty sandstone, loose on the surface, occurs just north of this exposure.

Fig. 15.—No rocks show north of this exposure for 1000 yards; but at the east end of the bridge over the Susquehanna river on the road from Antesport to Jersey Shore, there is a rock exposure along the river bank. The rocks are so much contorted and dislocated as to be useless for measurement of thickness, but useful as a guide to the horizons.

COAL IN LYCOMING COUNTY.

CHAPTER IV.

The Loyalsock Creek at Barbour's Mills.

§ 118. *Coal of X.*—In the vicinity of Barbour's Mills P. O. on Loyalsock creek, there are some trial openings in coal beds in the Pocono rocks, which are of considerable geological interest, though the beds of coal are small, slaty and of no practical importance.

At Barbour's mills, at and near the creek level, gray thin bedded sandstones, with red sandstone and red slates are the country rock.

On going up *Day run*, on the north side of the Loyalsock, the whole hill side is covered with loose stuff so that there is no rock exposure until thin bedded sandstones, fine grained and current bedded, are seen in place at 470 feet above the creek.

Mr. Day reports that directly under this sandstone ledge, he found, in cutting a log road, a small bed of coal and slate. It was never opened up at all, and showed on the crop some two or three feet of black slate, with perhaps two inches of coal.

Again the rocks are covered with débris and nothing shows in place until, at 760 feet above the creek, there is a massive current bedded gray sandstone, with some red layers above and below.

At 800 feet above the creek there is a layer of red clayey sandy slate, about three feet thick. Grayish and reddish gray sandstone comes in on top of it.

§ 119. *Day Coal opening, No. 1.* Section 12, Fig. 16.—At 840 feet above the creek level there is a small layer of black slate holding some coal.

The exposure shows on top:

Sandstone, current bedded, massive, fine grained, bedded, grayish,	10′
Sandstone, thin, gray colored, (with numerous small *coal* and slate seams of from $\frac{1}{8}''$ to $\frac{1}{2}''$ running through it,) much crumbled and rust stained,	4′
Fireclay,	1′ 6″
Sandstone underlying,	?

These little streaks of coal run very irregularly. At a distance of 20 feet under cover they widened out, but soon shut in again.

There is no reason to believe from the appearances that anything of value would be found by following up this lead; it is clearly one of the worthless Pocono *coal* beds.

Pocono conglomerate.—The mountain slope rises for 245′ above this Day coal; the rocks are sandstone, usually fine-grained and sometimes massive all the way up to the crest. It is not a conglomerate, nor is it conglomeritic; but occasionally one or two stray white rounded quartz pebbles will be seen in the rock face. A slight red surface wash is found occasionally even up to the top of the mountain. The top of the mountain seems to be clearly in Pocono rocks.

§ 120. *Day coal opening, No. 2.*—On the south side of the Loyalsock creek, abreast of his saw-mill, about one mile below Barbour's Mills P. O. Mr. Day opened up a small coal bed, 700± feet above the level of the Loyalsock creek.

He reports that he had as high as 8 inches and even 10 inches of coal; separated into two layers by hard blue colored sandstone; with red rocks on top of the coal.

Some little coal was taken from the opening and used in the blacksmith shop. The opening is now fallen shut and entirely disused.

This also is a local coal bed in the Pocono sandstones;

probably the same horizon as the one described on the north side of the creek, on Day run; or if not the same, it is not far from it.

§ 121. *Johnson's coal opening on Bear creek.*—Going up Bear creek from Barbour's mills, on the south side of the Loyalsock, red rocks are carried plainly up to Johnston's mills, 1½ miles above the mouth of Bear creek, but only about 100 feet in level above the Loyalsock.

At Johnson's the rocks are dipping gently to the north or north-northwest; while on the Loyalsock, at Barbour's mills, they are seemingly perfectly horizontal.

On the mountain side, east of Bear creek, there is no exposure of rock in place, above Johnson's house, until at 565′ above the Loyalsock, where the country rock is gray fine-grained sandstone.

This continues for 240 feet, to a height of 805 feet above the creek level. The mountain crest is sharply defined and very narrow.

The Johnson coal opening, on the east side of Bear creek, is 725 feet above the level of the Loyalsock creek. It shows:

Sandstone, current bedded, massive, fine-grained, ...	25′
Sandstone, crumbly, iron-stained and decomposed, carrying small knife edges of *coal*, ...	3′
Fireclay, ...	1′
Sandstone underlying.	

The description above sufficiently indicates that this is no coal bed, but simply a small coaly mass in streaks in the Pocono sandstone.

It resembles very closely the Day mine on the north side of the Loyalsock, on Day run; but is 100 feet lower in level.

If they be the same bed, therefore, the synclinal axis must pass somewhere near the line of the Loyalsock at Barbour's mills; but as these sandstones of the Pocono are so similar in appearance for hundreds of feet in thickness, the two coal streaked slate beds might easily be of different horizons, though they cannot in any case be far apart.

§ 122. *Rocky and Red ridge. Fig. 16, page 70.*—On the west side of Bear creek the mountain rises to 1300 feet above the level of the Loyalsock creek.

It is on this mountain, on the Loyalsock face, that Day's coal opening south of the Loyalsock was made. That opening, as has been stated, is only 700 feet above the creek, and 600 feet below the crest.

The whole mountain side is covered with sandstone pieces from top to bottom.

The crest is covered with great bowlders and masses of conglomerate sandstone; filled with white quartz pebbles of all sizes; and these bowlders have fallen down the hill some of them to the very bottom of it.

Yet Red ridge, which is just south of Rocky ridge, and of even height has its smooth hill top of soft red rocks.

The dip at this point is gently to the north.

The red rocks of Mauch Chunk red shale therefore seems to come in place all right on Red ridge; pass under the crest of Rocky ridge, but make no surface show, since the massive sandstone of XII has covered the whole mountain side with a deep coat of débris; and under the Mauch Chunk come in the Pocono, or Gray Catskill rocks.

The exposures are not sufficient to allow of any certainty as to the junction point of the Mauch Chunk and Pocono formations.

§ 123. *Woolever's coal opening.*—Four miles below Barbour's Mills P. O., on the north side of the Loyalsock, Mr. E. Woolever has opened up a small coal bed. Between Barbour's mills and Woolever's the country rock along the creek is about the same as above described, the stream following the synclinal axis line.

Coal in Brown Township, Lycoming County.

§ 124. The Blossburg synclinal axis passes through the northwest corner of Brown township.

The whole western part of the township, between Big Pine creek on the east and the county line on the west, is an unbroken wilderness, as little settled as at the time of the First Geological Survey of the State.

The Jersey Shore and Coudersport turnpike passes along the western border of the township: but there is even now only one clearing along the line of that road in Brown township.

It is *reported* that a 2 foot bed of coal has been found in the woods near the western line of the township.

The First Survey thus reported on the Third Basin Coal along the line of the Jersey Shore and Coudersport turnpike, Final Report (1858), Vol. II, p. 526.

"Mr. Hearod's tavern is situated in the Third Basin, and the coal, 1 foot thick, was once opened upon his land. It outcrops on a well marked bench upon the road, 1 mile north of his house. Here, as in many other places, the disintegration of the [Pottsville] conglomerate produces a fine white sand, well adapted to the purposes of the glassmaker. It is said that in sinking the well at Mr. Hearod's clearing, coal of good quality, and 3 feet thick, was struck at a depth of 20 feet below the surface. This would show its place to be from 40 to 50 feet above the conglomerate."

Chapter V.

*Little Pine Creek Division of the First Coal Basin.**

§ 125. Little Pine creek Coal basin lies almost entirely in Pine township, Lycoming county, though its western end crosses the west boundary line of Pine township and enters McHenry township. The basin dies on the head waters of Otter run, some 3 miles west of the east line of McHenry township.

The basin, like the other detached coal basins of northern Pennsylvania is a canoe-shaped synclinal, broad-pointed. It is really a continuation of the McIntyre Coal Basin.

The western point of the McIntyre Coal basin is 3 miles west of the eastern border of Jackson township; and the eastern end of the Little Pine creek basin is on the western border of Jackson township. While therefore the basin continues, geologically, as an unbroken synclinal yet such part of it as lies in Jackson township is thrown up so high by a rolling of the basin floor as only to take in the Pocono (X) as its highest rock even at the centre of the synclinal axis. The rising and sinking of the basin floor by which the coals come into or are cut out of the basin is shown in the sketch, Fig. 18, drawn along the length of the basins, and not across it. (See page 70 above.)

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* By Mr. Platt.

In the determinations of the anticlinal an synclinal axes across Lycoming county this has been made one continuous synclinal axis: and that determination is accepted in stating the geology as above.

§ 126. *Little Pine creek* basin starts in on the eastern border of Pine Creek township.

The high mountain crest of XII, north of Rock run, in the northeast corner of the township, marks the norther edge of the basin. This mountain is fully 2200′ above the ocean level.

A mountain of XII, not so high above the ocean however, on the south side of Wolf run, marks the southern limit of the basin.

There is therefore this small area of coal lying between Wolf and Rock runs and east of Little Pine creek.

But the great body of the coal lies west and north of Little Pine creek.

For Little Pine creek after flowing about due south for 5 miles from Texas P. O. and thus cutting *across* the coal basin, changes its course to southwest and keeps roughly parallel for a distance with its general direction and south of it.

The central line of the synclinal axis crosses Little Pine creek between Wolf run and Rock run, and to judge from one exposure, almost at the mouth of Rock run.

It then continues on its course to the west-southwest: is cut into by Four Mile run, Bonnell run, Pine run or English creek, the Buckeye branch and Otter run.

The coal measures have been opened up to some slight extent on most of these cutting streams.

The basin however is pointing out to the westward after it crosses into McHenry township and the massive rocks of XII make the crest on the main road near Brion's and Barton's places on the Pine Creek road: and the high lands on the divide between the waters of Otter creek and Mill creek in McHenry township are the pointing out places for the bottom of XII.

The distance as named between the extreme eastern and western limits of the basin is at least 11 miles: and the width from the north to the south outcrop is at places 2 miles and more.

Of course the producing coal measures do not cover all of this area: part of it being bare rocks of XII: and of the area covered by the Lower Productive Coal measures there is to be made a large deduction for loss by stream valleys, for the coals lie near the hill tops.

§ 127. The coal basin on Little Pine creek is almost as much of a total wilderness now as it was at the time of the First Geological Survey of Pennsylvania. The part of the Final Report relating to the Little Pine creek region is quoted below: the facts recorded then are still useful for any conclusions on the basin, and the record contains the important fact of the continuation of the Mauch Chunk group, even west of the Little Pine creek basin as a red rock group, holding the Mauch Chunk Iron Ore. The measures of XI are so completely covered in the basin itself as never to come to daylight.

§ 128. The Final Report of 1858 (Geology of Pennsylvania, Vol. II, page 517, from the report of Mr. J. T. Hodge), says:

"The next place in our progress west where this basin* contains coal is on the First Fork of Pine creek. Heavy masses of conglomerate strew the flats along the First Fork, about 3 miles from the mouth of Bear run which heads near Larry's creek. We no longer find the [Catskill] rocks above the streams, but they rise to their level near the Block House Fork and a little below the old English mills.

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*Speaking of the Barclay-McIntyre basin.

The hills are between 700 and 800 feet high, containing about 100 feet of the Conglomerate, supporting 100 feet more of higher strata. On a stream known as Three-mile or Porcupine run, opposite Wolf run, the Conglomerate and above it the brown sandstone, are well exposed. Between them no bed of coal was discovered: but above the sandstone a coal-seam was found consisting of two bands, each about 1 foot thick, separated by a layer of hard shale. The lower band in this seam is a beautiful black shining coal. Below it lies a bed of hard blue shale. Much search was made for *iron ore* but without success. Whether other beds of coal exist in this neighborhood is uncertain, but the country seems well deserving of further investigation. The Conglomerate caps the hills on both sides of the Fork, a little distance north and south from where the coal was found. On the east side of the Fork, and on the Block House branch, the indications of coal are less promising than on the west side. An unsuccessful search was made for the *iron ore* of the [Mauch Chunk] Red Shale. A ferruginous band in the red shale, about 150 feet beneath the conglomerate, implies that ore might be found here if an adequately minute exploration were made, assisted by proper diggings. Specimens, seemingly of good quality, were found sticking in the roots of trees between Porcupine run and the old English mills.

"About the time these discoveries on the First fork of Pine creek were made, a person seeking for limestone on a wild tract a few miles to the west, stumbled upon a bed of coal; a continuation perhaps of the seam above described. In tracing the basin in that direction, other beds were discovered and opened, to which I shall now refer. The localities are at the sources of Otter's, Day's, and English's runs, which empty into the First fork, and of Trout run, which empties into Big Pine creek below the second fork. The surface is gently rolling, but very elevated; the obscurity of the exposures, and a considerable amount of dip in the strata, cause the tracing of the coal in this neighborhood to be rather difficult, as a section made across the basin here would show.

"On the very highest lands to the north or northwest the [Pottsville] Conglomerate either caps the summits or leaves very little room for the "brown rock" which overlies it.

"A dip to the south carries down these rocks and soon brings in the coal at a level considerably below the tops of the hills; but the ground continuing to slope also to the south and east, it becomes difficult to determine how far the coal extends in those directions. About 3 miles north, on the road towards Babb's, the hill suddenly falls off about 200 feet, exposing the lower band of the [Mauch Chunk], and the upper part of the [Pocono] rocks, brought to this elevation by the south dip. Still further north, the level of the country is much lower. Where the road crosses Otter run, the "brown rock" above the Conglomerate just rises to the surface, forming the lower part of the bank. Above this is the lowest coal-seam, which is 2 feet 6 inches thick, containing a thin band of fireclay, and underlaid by another bed of fireclay two feet thick. The outcrop of another coal seam shows itself a little higher up in the same digging. The fireclay mentioned is of good quality, suitable for the manufacture of firebricks. Another coal bed was found, 25 feet above the last, in a neighboring bench in the hill. It was opened too near the surface to ascertain its quality. Its thickness is 3 feet 8 inches, including 2 inches of slate. Below it lies a bed of fireclay, similar to that of the middle coal seam. The extent of this upper bed cannot be great, but the other beds probably underlie 50 or more acres of surface.

"Tracing the Conglomerate towards the north, it appears near the top as a coarse pebbly rock, and lower down as a reddish brown sandstone. The thickness of the whole stratum is about 150 feet. On the north slope of the hill towards the old English settlement, the [Mauch Chunk] shales appear. About 200 feet lower down the soil indicates the lower red shale bed, and here possibly the *iron ore* may exist. The hills northwest of the coal-openings rise more suddenly, and contain the conglomerate. How much further the coal measures extend towards the south and east can only be ascertained by systematic diggings and accurate measurements beyond the resources of the Survey. At some places in those directions the elevation seems to be as great as the coal, but a change of dip must occur before we proceed far in that course. The brown sandstone is exposed below the coal on Otter run.

"Coal may hereafter be found at other points on these high lands between the First fork and Big Pine creek, but it cannot occupy much extent of surface. It may be worth the attention of the owners of lands lying on the head of the southwest branch of Otter run, or about 5 miles from Callahan's, to excavate for coal, as the appearances there are indicative of the coal measures, and the conglomerate does not reach to the highest summits of the country. Examinations were made there, both for the coal and for the iron ore of the [Mauch Chunk] series. A pit dug in the red shale about 12 feet did not, however, bring either substance to light; but it is probable that if the ore exists at all in this neighborhood it is chiefly in the lower bed of red shale, for we subsequently found it there on the west side of Pine creek, nearly opposite Callahan's. At this spot it was not, however, well exposed, being only 6 inches thick, and composed of hollow elliptical nodules, containing sometimes an undecomposed blue centre." . . . . .

There are comparatively few complete openings on the beds in the Little Pine creek basin; though there has been much of that wasteful and unsatisfactory opening up of outcrops just sufficient to disclose the presence of a coal bed, yet without detail enough to estimate its size and character or make a perfect identification of its geological horizon. And what complete work there is in the basin has been chiefly done within the past and present year, (1878, 1879.)

While these present openings enable an estimate to be made of the size of the beds and their positions in the measures with reference to each other and the underlying conglomerate of XII, there is a very imperfect opportunity to ascertain the character of the interval rocks. In interval distances the Little Pine creek basin evidently corresponds closely enough with its eastern continuation, the Ralston-

McIntyre division of the First coal basin; and probably the complete vertical section as obtained at the McIntyre mines will be found to apply to this Little Pine creek region.

§ 129. *General section.*—By compiling different imperfect sections obtained at different points in the basin the following generalized section is obtained typical of the Lower Productive Coal Measures in the Little Pine creek region, and their underlying rocks:

Section 11, Fig. 18. Little Pine Creek Basin.

Surface.			
Conglomerate sandstone massive,			10′
Coal E (?) smut,			—
Interval, chiefly massive sandstone, frequently conglomerate,			75′ to 85′
Coal D,	*Coal,*	2′	7′
	Parting,	3′	
	Coal,	2′	
Interval, sandstone,			21′
Coal, C′,			1′
Interval, sandstone,			13′
Coal, C,			1′ to 3′
Interval, usually shales,			18′ to 23′
Coal, B, "*Big bed,*"			4′ 6″ to 6′
Interval, chiefly clay slates,			15′ to 25′
Coal, A, small bed,			6″ to 1′
XII.	Conglomeratic sandstone,	70′	130′
	Fine grained sandstone,	60′	
X.	Pocono sand stone, current bedded, fine grained, micaceous; thin bedded, greenish and gray,		300′
XI.	Interval concealed, (and ? top of X),		120′
IX.	Catskill red sandstone, with some red slates,		40′
			795′

The detailed description to follow will explain the incompleteness of the record, and the difficulty in harmonizing the disconnected and sometimes apparently conflicting partial sections.

§ 130. *East of Little Pine Creek.*—At the eastern end of the basin the coal outcrops have been opened up for examination and a topographical map to show the acreage of coal in that region, has been made for the owners, Messrs.

Reese, of Phillipsburg, N. J. and others, who furnish copies of their topographical map, &c. to the survey.

The country is an unbroken forest, and rock exposures are rarely found. The exact nature of the interval rocks therefore cannot be given.

§ 131. The following very imperfect section was made on warrant 1601:

Slates,	9′ 0″
Coal; opened on crop; "Five foot bed"—say,	3′ 0″
Interval, apparently sandstone,	26′ 0″
Coal; smut of large bed; reported,	4′ 6″
Interval—down to top of XII not known,	?

The *upper coal* of this section, called locally the 5½ foot bed, has been opened enough to get out some coal for analysis. Mr. Seaman reports that where he opened it some few hundred yards away it yielded 3 feet of clean coal.

An analysis was made by Mr. McCreath, who reports it thus:

"Coal of a deep black color; rather friable; seamed with mineral charcoal and grayish black ashy coal; somewhat coated with iron oxide but seems in the main free from pyrites.

Water @ 225°,	3.830
Volatile matter,	22.985
Fixed carbon,	64.063
Sulphur,	.577
Ash,	8.545
	100.000
Color of ash,	reddish gray.
Coke, per cent. (rather inferior),	73.185
Fuel ratio,	1: 2.79

The high percentage of water in this analysis is probably due to the coal being washed rudely and sent on wet. It came from near the outcrop.*

The *lower coal* bed was opened up enough to show a good smut and solid coal.

These are probably coal beds B and C: they *may be A and B*, but it is not likely.

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*The specimen came from an old shaft, exposed for years to freezing and thawing. Mr. McCreath's experiments at Harrisburg show that the effect of this is to materially injure the coking qualities of coal.

These are the only coals of value on the east side of Little Pine creek.

§ 132. If the coal acreage on the map be correctly laid in there are several hundred acres of coal on the east side of Little Pine creek.

The Conglomerate of XII makes a very distinct north wall to the coal basin at this point, and also comes out very plainly on the south of Wolf run.

The basin is rising very rapidly east of Little Pine creek to its eastern canoe shaped point and the coals and the underlying conglomerate are shortly carried out high into the air.

§ 133. *West of Little Pine Creek.*—In the centre of the Little Pine creek coal basin, west of the creek, the topographical map shows that there are at the deepest part of the basin, some 170 feet of Lower Productive Coal Measures overlying the conglomerate of XII.

This depth of measures is only on one small round knob.

§ 134. *Mahoning Sandstone and Coal Bed E.*—On the hill the crest is made up of massive conglomerate sandstone, 10 feet of it in all remaining. It represents the massive conglomerate sandstone overlying coal bed E. of the McIntyre mine section. This sandstone can fairly be identified as the Mahoning sandstone of the Clearfield and Cambria county sections.

A coal smut is reported by Mr. Seaman as showing just below the massive conglomerate. This would be the bed E of the McIntyre section.

It is of importance geologically to establish the regularity of these measures and their correspondence with the McIntyre section. It is of course of no practical importance, as the area covered by the coal bed E and the Mahoning sandstone scarcely amounts to one or two acres in all.

§ 135. *Interval rocks under coal bed E.*—Below bed E there are from 75 to 85 feet of rocks. At the McIntyre mines these rocks are very hard massive conglomerate rocks. They seem to be of the same character in the Little Pine creek basin.

It is owing to the protection afforded by this hard massive rock that there is so much coal area remaining in the Little Pine creek basin.

The rock is frequently yellowish in color, is fine grained, and the conglomerate pebbles are usually small, of white quartz. It does not make specially noticeable cliffs, and rarely breaks off in great masses; generally in pieces of moderate size.

§ 136. *Coal bed D.*—This is in no place fully opened up. It appears to be always a double bed; but with a parting so large between the benches of coal as to entirely spoil the working value of the coal as one bed.

If the identification be correct, and it seems to be so, this is the bed of which the upper bench only is worked by Mr. Bannan.

The Bannan mine.—The upper bench of the coal has been worked in a small way at the Bannan mine, 3 miles north of English Centre, and close to the outcrop of the bed on the north side of the basin. The mine is run in to the northwest and the coal is rising rapidly to the north or north-northwest. It shows:

Clay slate roof.	
Coal, variable,	1′ 9″ to 2′ 10″
Sandstone floor.	

The opening shows a very treacherous clay slate roof, and a most uneasy sandstone floor. The coal bed at this point is therefore entirely unreliable, swelling up to nearly 3 feet in thickness or pinching down to less than 2 feet in thickness in very short distances.

The mine has not been worked to any extent; only in a small way to supply some slight local demand. If it should be driven for any distance on its present course it would soon come out to daylight on the north outcrop.

The coal itself was very friable and columnar, jet black in color, and comes out of the mine much crumbled, making a large proportion of fine coal. It is *reported* that the coal is preferred by blacksmiths for their fires. As the cover at the mine is small the coal is somewhat rusted and soiled by infiltration.

No lower bench of coal was seen at this mine. It is *reported only* that such a bench exists.

A specimen of the coal from the Bannan mine was analyzed by Mr. McCreath, who reported thus:

"Water at 225°,	1.020
Volatile matter,	21.865
Fixed carbon,	69.324
Sulphur,	.749
Ash,	7.042
	100.000
Color of ash,	cream.
Coke, per cent.,	77.115
Fuel ratio,	1 : 3.17

"The coal is considerably coated with silt; rather tender; and has a dull black lustre on fresh fracture."

§ 137. On the hill slope above the "Old Bache mine," and between 50 and 60 feet by barometer above the Big bed (B) a coal bed has been opened on the outcrop and worked slightly.

It has fully 60 feet of covering rocks where opened, and is *reported* to have shown some 24 inches of coal at the working face when abandoned. The miner also *reports* that underneath the upper bench coal there came in another coal, thus:

Coal, upper bench, up to	2'
Fireclay parting,	3'
Coal, running up nearly to	2'

Only the upper bench was opened up and worked; and that the blacksmiths all preferred it to the coal from the Big bed. This drift is now entirely closed.

Judging from the pieces of coal now lying around the mouth of the abandoned drift the coal seems to resemble strongly in appearance and structure the coal from the Bannan mine; but being under better cover was not rust-stained nor covered with infiltrated stuff.

This opening therefore is in all probability on coal bed D of the section.

§ 138. *Otter run coals, Sec. 12, Fig. 19.*—At the old openings on the west side of Otter run, this imperfect section now shows:

Hill top,		
Interval, rocks not seen,		10
Coal, (D?)	up to	2′
Interval rocks,		70′
Coal,	*reported*, not seen,	3′
Interval,		25′ to 40′
Coal,	*reported*, not seen,	3′
	Total,	128′

Nothing to be seen below.

The upper coal of the above section was opened in a shallow shaft. It was small, scarcely running up to 2 feet in thickness. This was probably the upper bench of Coal D.

In the description of the Otter run measures in the Final Report of 1858, one of the lower coal beds is given as 3 feet 8 inches of coal.

Without attempting to make any certain identification in the absence of new openings on the coal it seems likely that this section on Otter run represents coal beds A, B and D.

§ 139. *Coal D? on Four Mile run.*—There is an old coal opening at the head of Four Mile run, about one or one and a half miles west of Little Pine creek. Its level is about 1800 feet above the sea: and while its geological horizon is not precisely determined yet it most probably is an opening on this same coal Bed D, or the double bed.

The coal, where opened, has fully 45 feet of cover, seemingly at this place made up of thin sandstones and some little shale: the sandstone is filled with impressions of *fossil plants*. The coal is opened on a narrow hill top and covers only a limited area at this point.

The same bed (?) has been opened on the next warrant, and 30 feet lower in level; and another trial pit some 400 yards east of the old opening, and on the same level, found the coal in the same condition as at the original trial drift.

The massive Conglomerate of XII is seen in place on the hill side some 110 feet below the coal, and from that on up the hill for some little distance; but there are softer rocks between the top of XII and this coal bed, and corresponding therefore both in interval, distance and nature of interval rocks to the measures between the top of XII and coal bed D.

On measuring the coal bed at its somewhat imperfect exposure at the head of Four Mile run, it showed on the face:

Sandstone, thin bedded,	1′ 0″+
Dark carbonated clay slates,	3 0
Bony Coal and mixed stuff,	0 6
Coal, in one bench,	2 0
Floor not seen.	

This was seen near the crop, as the main opening had fallen shut and could not be entered.

The coal itself looks hard and good; shows very little iron pyrites, but carries through it many small lenticular masses of bone coal or slate which would probably make it run high in percentage of ash.

The coal is bright and resembles more the coal from Bed D than that coming from the Big Bed.

§ 140. *Measures below D.*—As usual in this Basin these interval rocks have been only partially seen. But there seems to be some 20 feet of sandstone, thin bedded and with no specifically noteworthy characteristics.

Coal Bed C′.—At the new Bache mine (which is on Bed B) some trial openings have been made on the hill side above, and coal bed C′ was opened 33 feet above B.

The trial opening showed at the face:

Roof slate.	
Coal,	1′ 0″
Sandy fireclay,	2 6

The measures were entirely regular and as the coal was well cut into there is no special probability of an increase in thickness. There is plenty of cover, fully 75 feet, and the hill top is crowned with the massive conglomeratic sandstone which overlies Coal Bed D.

This is the only place in the basin where this small coal bed C′, has been opened up, so far as the examination disclosed.

The coal looked well enough, but the bed is too small to be of any practical consequence.

§ 141. *Measures under C′.*—The measures underlying bed C′ are sandstones, thin bedded, and 13 feet in thickness. There is nothing about them to make them serve as a guide in working out horizons in the basin.

Coal bed C.—This coal has only been opened on the outcrop for measurement.

On the east of Little Pine creek it appears to be a bed of considerable, though rapidly varying thickness, and of good character, as shown by the analysis.

On the west of Little Pine creek the smut of the coal has been found on the outcrop, but there is no evidence that it possesses any sufficient size to be of practical value.

The evidence points to its being of irregular size and character, and in its present undeveloped condition its presence adds nothing to the value of the basin.

§ 142. *Measures under C.*—The measures under C are sandy slates 23 feet thick. They are not persistent, frequently running into thin slaty sandstones, and offer no guide in judging of geological horizons in the basin.

§ 143. *Coal bed B.*—The "Big coal bed" of the Little Pine creek basin, is the most important and valuable feature of it.

It is the only persistent coal bed of workable size; and it lies somewhat down in the hills, under abundant cover, and spreads over a very extended area.

The bed had been opened in several places and has been mined for many years in a small way to supply the limited local demand.

§ 144. *Old Bache Mine, Section 13, Fig. 20.*—The coal has been opened by Mr. J. W. Bache, of Wellsboro', and worked by him in a small way for local use. The mine is 3½ miles north of English Centre on Little Pine creek, and is about 1660 feet above sea and about 610 feet by barometer above the level of Little Pine creek at English Centre. It is opened on the bank of a small run, and is driven in to the westward.

The coal was measured in the mine and shows:

Big Bed B.	Roof slate, Coal, Black slate, — imperfectly seen, and not worked, — reported,	1' 10"
	Black slate,	4" to 0' 5"
	Coal,	10" to 0' 11"
	Black slate,	4 ' to 0' 6"
	Coal,	1' 10"
	Black slate,	4" to 0' 5"
	Coal,	1' 0"
	Total,	6' 11"
	Fireclay floor.	

A specimen of the coal, representing all the three lower benches (now worked) was forwarded to the Laboratory of the Survey and yielded on analysis (A. S. McCreath):

Water at 225°,	.450
Volatile matter,	20.040
Fixed carbon,	64.159
Sulphur,	.656
Ash,	14.695
	100.000
Color of ash,	Grey.
Coke, per cent.,	79.51
Fuel ratio,	1 : 3.20

"Bright resinous luster; generally firm; seems in the main free from pyrites; carries numerous thin bands or lenticular masses of slaty coal."

It is reported by Mr. Bache that there is a coal bed 14 feet below his Big bed at this mine.

§145. *New Mine on the Big Bed. Section 14, Fig. 21.*—Mr. Bache has again opened the Big bed of coal about 1 mile to the south of the old Bache mine.

The hill rises high above this mine and the cover is abundant. The mine runs in southwest: the coal dips to the southwest on the crop, and in the working face seems to dip to the south.

Massive sandstone appears to come up solid to within 15 or 16 feet below this coal. It is not reported that any coal has been found below it, and the sandstone is seemingly solid up to where at the old mine one mile away, a lower coal was reported as found

The mine when examined had been driven in only 25 or

30 feet, and the coal was still much decomposed: no coal hard enough to test by analysis having yet been reached. On testing outside pieces of coal on a fire the coal burned well, and possessed a decided coking character.

The coal as measured in the working face shows:

Big Bed, B.	Surface soil.			
	Dark soft clay slate, turning into a sandy slate,		2′ 0″	+ —
	Bone coal and mixed stuff,		0 3	
	Coal,	1′ 0″ to	1 3	
	Black slate and bone coal,		0 6	+ —
	Coal,	10″ to	1 0	
	Slate,		0 2	+ —
	Coal,		2 0	
	Bone coal, with slate and clay,		0 6	
	Coal, reported, not seen,		0 8	
	Fireclay floor.			

The bottom layers of bone coal and coal, not taken up, could not be seen. They are given as reported by the miner.

The slate partings seemed to have a tendency to increase in size above the dimensions given, rather than to decrease; but there is clearly a mass of four feet of coal, or a little more; and the deposit is a very valuable one.

§ 146. It will be noted from the vertical sections that there are some considerable differences in the coal bed at these two openings, although the mines are only one mile apart and directly along a continuous well marked bench which makes the crop of the bed. In fact where the bed is so large the bench mark of it is very plainly defined, running around the hill sides conspicuously.

§ 147. *English Mine on the Big Bed. Section 15, Fig. 22.*—It is on English run, 2½ miles to 3 miles north of English Centre, and scarcely 1 mile from the New mine on the Big bed just described.

It is about 620 feet above the level of Little Pine creek at English Centre, and 1660 feet above the ocean level.

The mine runs in to the south and drains freely, the measures rising in that direction. It is therefore south of the centre of the synclinal axis, and on the south side of the basin.

There is plenty of cover over the coal at this place, (nearly 100 feet) and the bench on which the mine is opened is as clearly defined at the other openings on this bed. Clay slates overlie the coal bed, and come in also under the floor of it.

The mine was not working when the region was examined and (the drain having choked) was partially filled with water. The mine was driven in some 800 or 900 feet in all under the hill. It is opened on what were known as the "Herdic lands," now the Weightman property.

The coal in the English mine measures thus:

Big Bed, B.	Roof slate.	
	Coal,	1′ 1″
	Bone coal,	0 7
	Coal,	1 1
	Slate,	0 2
	Coal,	1 4
Total,		4′ 3″

Specimens of all three benches of the coal bed were analysed by Mr. McCreath, who reported as follows:

"The coals are of dull black luster; firm and compact; with numerous bands of slaty coal and partings of charcoal. Seems in the main free from iron pyrites."

	Upper bench.	*Middle.*	*Lower.*
Water at 225°,	.760	.900	.860
Volatile matter,	19.700	20.250	19.820
Fixed carbon,	6 390	68.962	65.328
Sulphur,	.675	.593	.817
Ash,	10.475	9.295	13.175
	100.000	100.000	100.000
Color of ash,	grey.	grey.	grey.
Coke, per cent.,	79.540	78.850	79.320
Fuel ratio,	1 : 3.47	1 : 3.40	1 : 3.29

A specimen of coal representing the average of all the benches at the English mine was forwarded to the Laboratory of the Survey and analysed by A. S. McCreath who reported as follows:

"The coal has a dull black luster; is firm and compact; has numerous bands of slaty coal; seams in the main free from iron pyrites."

Water at 225°,	.500
Volatile matter,	19.945
Fixed carbon,	67.697
Sulphur,	.533
Ash,	11.325
	100.000
Color of ash,	cream.
Coke, per cent.,	79.555
Fuel ratio,	1 : 3.34

§ 148. *Otter run coal.*—In the Final Report of 1858 already quoted, mention is made of an old opening on *Otter run*, showing 2 feet 6 inches of coal with a fireclay parting, and a fireclay floor, and an upper bench of coal showing in the same digging. These benches represent probably bed B.

When the Otter run region was examined for this Report (in 1878) the old Otter run openings were found, on the west side of the run, but entirely fallen shut. No measurements could be made either of the thickness of the coal beds, or of the character in detail of the parting rocks between the coals. These openings are somewhat higher in level above the sea than the English and Bache mines near the centre of the basin; and as the basin is rising to the westward this greater elevation was to be expected.

§ 149. A trial opening made recently at the head of Four Mile run, west of Little Pine creek, and near the centre of the synclinal, found the bed parted thus:—

Coal,	1′ 6″
Slate,	0 2
Coal,	1 0

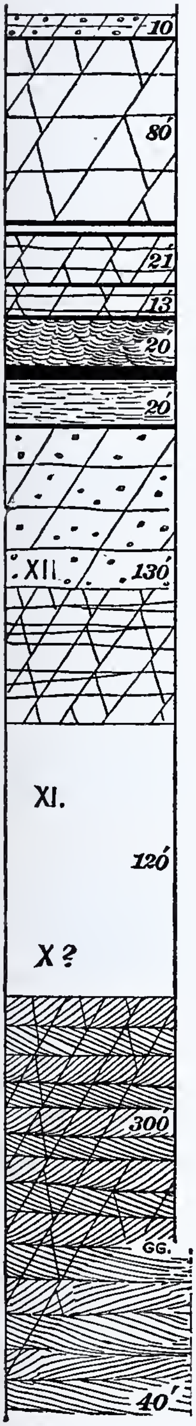
The drift was not in yet to solid coal but the coal bed gave evidences of being valuable.

A small black slate show has been cut on the hill side some 30 feet above this coal.

§ 150. *The Measures under B* are not clearly exposed in detail at any single place in the region. They seem to be clay slates, or clays: thickness from 15 to 30 feet: resting directly on XII.

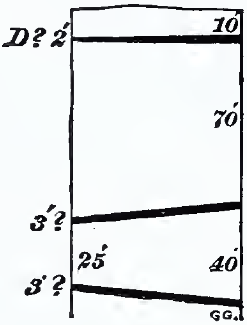
In this mass of slate and clays it is *reported* that a coal bed was found at the Bache mine, 14 feet below the Big bed; and this was considered enough to identify the Big

Sec. 11. Fig. 18. *Little Pine Creek Section. Lycoming County.*

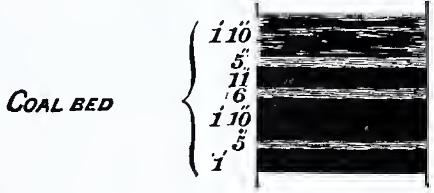


Otter run.

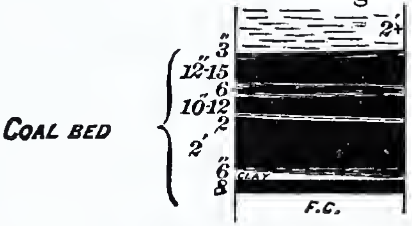
Sec. 12. Fig. 19.



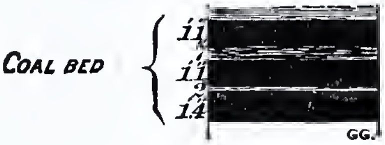
Sec. 13. Fig. 20.



Sec. 14. Fig. 21.



Sec. 15. Fig. 22.



bed here with the Bloss coal (Bed B) of the Blossburg basin, and this underlying coal with the Bear creek bed.

In no other part of the basin, except at the Bache mine, is there any coal bed reported under the Big coal bed.

It will be shown in describing the beds of the McIntyre region, that the measures just above the top of the Conglomerate (XII) have a coal bed, called Bed A, made up of numerous small benches of coal separated by large fireclay partings; and that Bed B comes in only about 10 feet above it; always as a double bed, and sometimes in three or more benches.

The conclusion may be fairly drawn that the Big bed of the Little Pine creek basin is bed B of the McIntyre basin; and that the coal A of the McIntyre basin, which is there only a few inches thick in places, is in the Little Pine creek basin even smaller and more variable than at McIntyre: at times indeed it may be entirely lacking; for example, at the new opening on the Big coal bed, the massive sandstone is seen only 15 feet below its floor.

There is no reason to believe that any coal of practical value exists along Little Pine creek below the Big coal bed, so far as all present developments show.

§151. *Area of the Basin.*—From the extreme western end of the McIntyre coal basin to the eastern end of the Little Pine creek basin is about 6 miles, only two thirds of the width of Jackson township.

§152. *Pottsville Conglomerate, No. XII, and underlying measures of XI and X on Little Pine creek.*—These are exposed in some places in the Little Pine creek coal basin, but at no place in full detail.

§153. *Section on Little Pine Creek*—On the west side just above the mouth of *Four Mile run* the hill side gives the following. Fig. 23:

Coal measures,	185′ 0″
Pebble rock, XII, massive, making a cliff along the hill side, the pebbles of white quartz, the conglomerate being as layers in fine grained sandstone,	70 0

Sandstone fine grained, massive, but without any pebbly layers,	60	0
Surface covered deep with fallen pieces of XII,	120	0
Sandstone, current bedded, gray, thin bedded, micaceous; upper part however chiefly concealed,	300	0
Level of Little Pine creek.		
Total,	735	0

§154. *Section on English Run.*—North of English Centre, the measures underlying the coal measures are partially exposed, thus:

Coal measures, Pebble rock, massive, Sandstone, very massive fine grained,	at least	100′	0″
Concealed by débris,		100	0
Sandstone, thin bedded, current bedded, gray, micaceous, not well exposed for detail,		300	0
Red sandstone and slates,		40	0
Total,		540	0

These exposures are sufficient to show that the massive sandstones of XII, the lower layer (60 feet thick) of fine-grained sandstone without conglomerate layers, the upper layer 70 feet thick and one half made up of pebble rock, are in all over 130 feet thick.

§155. *Mauch Chunk.*—Nothing shows on the hill sides just below the bottom rock of XII; for the débris deeply covers everything. This concealed interval contains what there is of XI. The Report of 1858, already quoted, shows the red shale to exist west of the Little Pine creek basin.

At McIntyre, XII and XI together are only 150 feet thick. It looks as though in the Little Pine creek region the sandstone of XII had increased in size at the expense of the soft rocks of XI. It has not cut them all out, for the Report of 1858 mentions a trial pit for the ore near the west end of the basin as 12 feet deep in red shales. But XI has evidently suffered in order to increase the thickness of XII.

§156. *Pocono.*—The thin bedded, micaceous, greenish and grayish colored, current bedded sandstones of the hill sides along Little Pine creek, resemble lithologically the sandstones occupying the same geological horizon along Lycoming creek in the McIntyre coal basin. From 300 to 350 feet of these gray sandstones show, and at their base 40 feet of red sandstones and shales. This brings the section to the level of Little Pine creek.

It is possible that the junction of the gray sandstones with the red sandstones and shales may mark the division line between Pocono (X) and Catskill (IX); but it seems more likely that the red sandstones at the creek level are colored layers in X, and that the true junction is deeper down; for at McIntyre there are not less than 650 feet of Pocono rocks. It is true that the thickness of X may have diminished by one half in the distance between Lycoming creek and Little Pine creek; yet it must be remembered that the Pocono is by no means always gray, nor the Catskill red.

Taken as an average, the Pocono is made of micaceous grayish rocks with some few occasional red layers; and the Catskill is made of red sandstones and slates with some greenish gray sandstone layers.

But the thin red layers in X frequently increase and show almost everything red colored for 100 feet or more; and the gray rocks frequently come into the section of IX in heavy masses.

§ 157. *Character of the coals of the Little Pine creek basin.*

In considering this it will be found convenient to have the analyses grouped together for comparison, thus:

BED.		Water.	Vol. Mat.	Fixed C.	Sulphur.	Ash.	Coke.
D, ...		1.020	21.865	69.324	.749	7.042	77.115
C, ...		*3.830	22.985	64.063	.577	8.545	73.185
B		.450	20.040	64.159	.656	14.695	79.510
		.500	19.945	67.697	.533	11.325	79.555
	Upper bench, ...	.760	19.700	68.390	.675	10.475	79.540
	Middle bench, ...	.900	20.250	68.962	.593	9.295	78.850
	Lower bench, ...	.860	19.820	65.328	.817	13.175	79.320
	Average, ...	.694	19.951	66.907	.655	11.793	79.355

* The specimen analysed was very wet.

Little Pine creek coal is therefore a steam coal, as may be seen by the following table of some of the principal steam coals of the United States:

	Water.	Vol. Mat.	Fixed C.	Sulphur.	Ash.	Coke.
Cumberland,*	1.562	14.197	73.951	‡	10.407	84.760
Clearfield,†	0.806	21.707	73.259	.573	3.655	76.000
Blossburg,†	1.465	19.741	68.974	.686	9.134	78.500
Snow Shoe,†	1.030	23.810	68.985	.767	5.408	75.340
Reynoldsville,†	1.050	32.13	61.265	.855	4.700	66.820

* Average, from the report of Walter R. Johnson.

† Average, by Andrew S. McCreath.

‡ Not given.

§ 158. *General conclusions.*—In view of all the detailed facts as already given the general conclusions concerning the Little Pine Creek Basin may be briefly stated thus:

The basin is large and valuable. The shape is that of a broad pointed canoe; the eastern end being near the east line of Pine township and the western in McHenry township, west of Pine township, on the head waters of Otter run.

In shape across from north to south the basin is peculiar, as shown in Fig. 24, page 112, the great body of all the coal lying between the high north outcrop and the centre of the synclinal; for the coal basin rises for a short distance only to the south before the falling off of the ground, and the increasing north dip cuts out the coal measures from the hill. Thus from the centre of the basin almost the whole of the coal would be worked out on a rise to the north.

§ 159. That part of the basin lying *east of Little Pine creek*, between Wolf run and Rock run has been but little explored. The basin is rapidly pointing out to the eastward and the rocks are therefore brought up very high into the air. The lower coal bed however, the *Big Bed*, should cover some considerable area of this high land between the streams before pointing out towards the east.

The high mountain of XII *north of Rock run* shows clearly the basin limit on the north side; this crest is some distance north of Rock run, and would leave room for some coal measures.

On the *south of Wolf run* the high crest of the mountain shows the conglomerate rim of the basin on that side.

§ 160. *West of Little Pine creek* the basin widens, and the chief value of the basin lies in the warrants in this part of it. The streams have cut out wide valleys, and removed large areas of coal, but a notable acreage of valuable coal lands remains.

A mountain of XII, covered deep with masses and bowlders of conglomerate, marks the north limit of the basin. The south limit is much less clearly defined, topographically, owing to the shape of the basin already described.

The coal measures continue through to and cross Otter run; and the western nose of the basin is at the main road, 3 miles west of the west line of Pine township, and on the head waters of Otter run. The extreme western high, narrow end points out soon after crossing the main road.

§ 161. The *topographical map*, with geological cross sections, accompanying this Report was made by E. H. Burlingame, of Williamsport, for some of the owners of the Little Pine creek coal basin. The work is closely done, the outcrop lines of the coals laid on, the shape of the hills shown by contours, and all needed information condensed on the one sheet. The map is given as illustrating the shape of the coal basin, &c., without endorsing the coal outcrop lines as absolutely correct. So far as the work was examined it seemed to be careful and as accurate as the heavily wooded country permitted.

The amount of available coal is easily calculated on a basis of 1600 tons to each foot of coal in the bed, or 5000 tons to a 3½ foot bed, per acre, the waste being small. As it is likely to be many years before coal beds of 2 feet 6 inches are worked to profit in these detached coal basins, areas of beds below this limit should be excluded from the calculation.

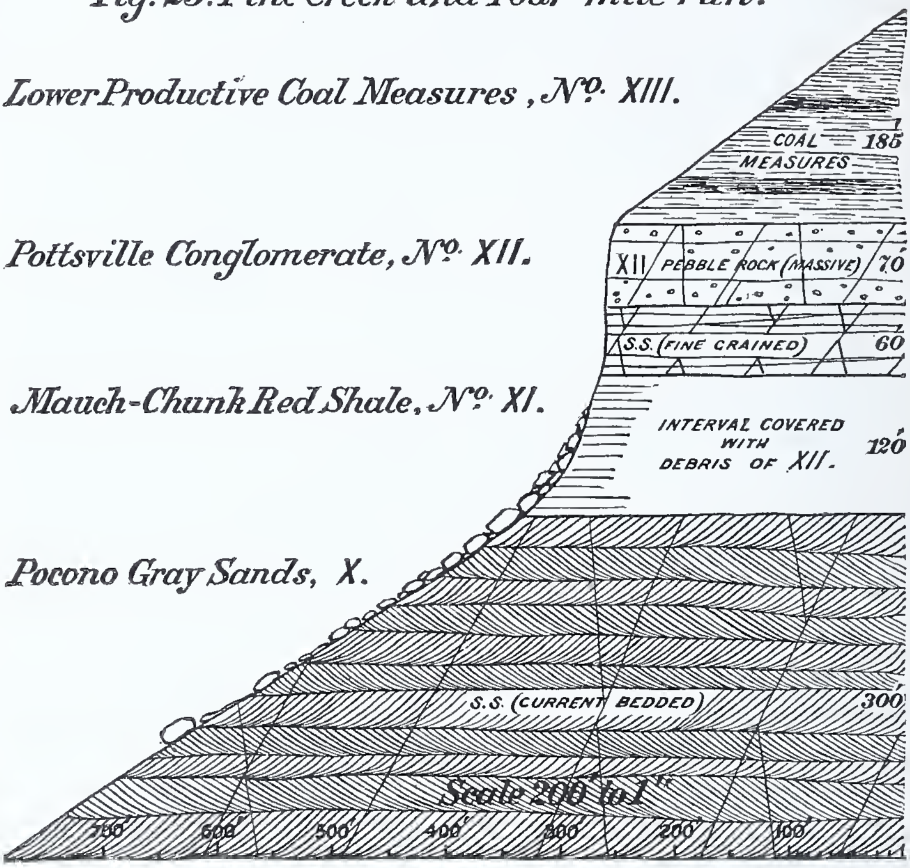
§ 162. *Avenues to Market.*—It is plain, from the detailed report already given, that the Little Pine creek coal basin possesses one large and valuable coal bed, of excellent character as a steam coal, and that this coal bed covers an extensive area in a shape favorably situated for its being mined cheaply. The question remains, What are its natural markets, and how can those markets be reached?

§ 163. *The Pine Creek railroad* is intended to run from Jersey Shore on the Susquehanna river, up Pine creek, to cross the divide in Potter county, and then, on the waters of the Allegheny river, at Port Allegheny, join with the Buffalo, New York and Philadelphia railroad.

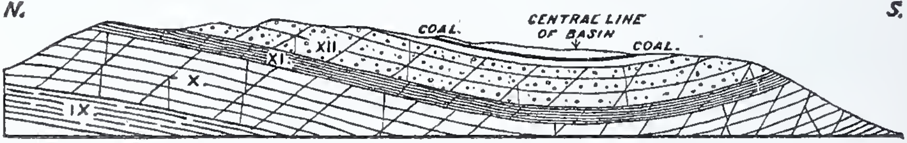
A branch railroad down Little Pine creek would therefore place this coal in communication with the great market for such coal at Buffalo; or it would give it an opportunity to compete for the large steam coal and iron mill trade to the southward. With reasonable rates the coal could certainly reach Buffalo in full and fair competition with any of the steam coals now in that market. And it should reach the valley of the Susquehanna at Jersey Shore fully as cheaply as the Snow Shoe coal. which would be its natural competitor.

There is, moreover, another possible outlet for the basin via Antrim and the Corning, Cowanesque and Geneva railroad. This line would deliver the coal in central New York, and with the cheap mining which should be possible on bed B, the coal ought to be able to go into that market at a profit.

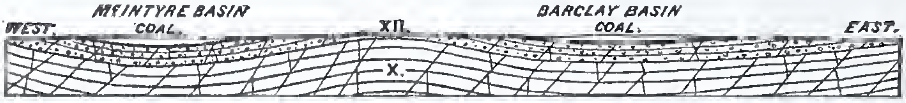
Fig. 23. Pine Creek and Four-mile run.



§158. Fig. 24.
Pine Creek Coal Basin. Lycoming County, Penna.



§164. Fig. 25.
McIntyre-Barclay Coal basin shown lengthwise.



CHAPTER VI.

RALSTON DIVISION OF THE FIRST COAL BASIN.

The McIntyre Coal Basin.

§ 164. It has already been shown that the McIntyre coal basin of Lycoming county is only the continuation to the westward of the Barclay basin on Schroeder creek, in Bradford county. It was pointed out that both the Barclay basin and McIntyre basin are somewhat canoe-shaped, synclinal basins; that a roll or swelling of the whole bottom of the synclinal axis comes in between the two coal basins, and that, for a broad area, near the Bradford-Lycoming-Sullivan county line, the Pottsville Conglomerate and Lower Productive Coal Measures are entirely cut out even from the center of the synclinal axis. A cross section along the line of the basin Fig. 25, page 112, shows this structure.

As a coal basin carrying Coal Measures, it has its eastern end at a point in McIntyre township, some two miles west of the Bradford-Sullivan-Lycoming county line.

Coal measures cap the hills on the second and third branches of Rock run (called Stony creek in old reports,) on Hound run, and between the first branch of Rock run and Lycoming creek.

The McIntyre mines, now in operation, are in the last hill of this range.

Crossing Lycoming creek, the center of the basin is close to McIntyre, and the same coal measures have been opened on Frozen run and Red run, west of Lycoming creek.

§ 165. As a basin carrying Lower Productive coal measures, it extends for about seven miles west of Lycoming creek, reaching into Jackson township. But before reaching the mountain road, which crosses from Trout run to Block House, these *coal measures* are all cut out by the rising of the floor of the whole synclinal, (as already explained in § 125, page 87,) at the east end of the McIntyre basin, and the synclinal ceases to hold the conglomerate of XII even in its deepest part.

§ 166. The developments of coal and iron ore along Lycoming creek and its branches, were examined by Mr. James T. Hodge, of the First Geological Survey of Pennsylvania, in 1848. The lower coal beds were then worked, and the iron ores of XI were in use at the blast furnaces. These lower coals and iron ores are not now working. The brief notice of them in the Geology of Pennsylvania (1858,) vol. II, page 513, is as follows:

§ 167. "*The Ralston coal field* is only an extension of that of Towanda, westward along the second basin. Ralston is situated at the mouth of Stony or Rocky run, on Lycoming creek, twenty-six miles above Williamsport, on the line of the Williamsport and Elmira railroad. The hills, which are about 1,000 feet high, contain, at their base, the red rocks lying at the base of the Vespertine sandstone series, and surmounted by the conglomerate limestone.

"The center of the coal basin crosses Lycoming creek, near the mouth of Dutchman's run, one mile above Stony run. The anticlinal axis, forming the south margin of this basin, crosses near the mouth of Pleasant stream, while the other axis, bounding it on the north, passes near the mouth of Roaring creek. The hills, including the coal measures, occupy a range of country east and west, nearly ten miles in length; but the coal is not continuous over all this extent, being interrupted by deep valleys of denudation. The principal localities of the coal are on a branch of Stony run, between that stream and Dutchman's run, on Red run, the other side of Lycoming creek, and on Frozen run, near Astonville. At Ralston a wagon road, at a grade of one foot elevation to every seventeen, ascends three miles to the mines. The height of the coal above the creek at Ralston is about 875 feet, while Ralston itself lies 808 feet above the tide.*

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*The tide level data of the Northern Central railway, in Report N, make Ralston station 876 feet above the ocean level.—*F. P.*

§ 168. "*The mines of McIntyre and Robinson* are situated on Stony run, three miles from Ralston. The coal bed worked by them varies from 2½ to 3 feet 2 inches in thickness; the coal highly columnar, and yields a white ash. Iron ore is found in the same position as at Ralston.

§ 169. *Ralston ore.* "On the road leading to the mines, and below the conglomerate, in a bed of dark shale, there is a valuable band of *iron ore*, lying only 4 feet beneath the rock, from which it is separated by a layer of brown shale. It occurs in irregular knotty lumps, closely bedded in a soft reddish and white shale. It forms about one half of the stratum, and consists of nearly a white crystalline protocarbonate of iron, somewhat resembling a fine grained sandstone. This is apt to be encrusted with the brown or red oxide. These balls are very solid and heavy, becoming more massive as we penetrate deeper in from the outcrop. In the other half of the bed, which is principally shale, occur scattered balls of the same ore, of a blotched red and white appearance. This ore is admirably suited for the manufacture of foundry iron. This is the valuable [Mauch Chunk] red shale ore of XI.

§ 170. *Pottsville Conglomerate.* "The Pottsville conglomerate in this region varies from 45 to 100 or more feet in thickness; the top of the rock is marked by a terrace, gently receding from the front of the hill to an abrupt slope, formed by a bed of white pebbly sandstone.

Coal measures.—"Between these two sandstone beds we find a seam of rather slaty coal, from 18 to 30 inches thick, underlaid by 30 inches of slate.

"Over the sandstone occurs another bed of coal, several feet thick, but not of superior quality, the lower part of it consisting of slaty cannel coal, the rest being rather hard. It includes two bands of slate: one 8 inches, the other, near the bottom, 3 inches thick.

"Another coal seam, between one and two feet thick, occurs from 5 to 7 feet above the former. It contains three inches of slate near the middle, but supplies an excellent coal for coaking, and is much superior to the seam beneath it.

"Above this coal we find a bed of shale, containing large nodular balls of *iron ore*, and a little higher another seam of coal one foot in thickness.

§ 171. *Ralston old mines*, Section 16, Fig. 26, page 118.—"A complete section of the strata in the descending order at the Ralston old mines, on the 3000-acre tract is appended:

	CONGLOMERATE crowning the hill,		60′ 0″
	Interval unknown.		
	Sandstone, shelly, thin bedded,		4′ 0″
	Shale holding *ore balls*,		10′ 0″
	Coal bed,		1
Slate,	Black slate and shale,	20′ 0″	23′ 5″
	Ore balls,	0′ 5″	
	Slate,	3′ 0″	
	Sandstone,	1½′ to	4′ 0″
	Coal bed,		2′ 0′
	Fireclay, good,		3′ 0″
	Slate, strong,		4′ 0″
	Coal bed,		2′ 8″
	Fireclay and Shale, sandy,		10′ 0″
	Coal bed,		1′ 6″
	SANDSTONE, CONGLOMERATE,	24′ to	30′ 0″
	Coal bed,	1′ to	1′ 3″
	Clay slate and Shale,		10′ 0″
	Coal bed,		0′ 10″
	Shale,		4′ 0″
	Coal bed,		0′ 8″
	Clay slate,	3′ to	4′ 0″
	Sandstone, strong, brown,		4′ 0″
	CONGLOMERATE,	7′ to	8′ 0″
	Slaty clay,	6′ to	0′ 8″
XI	*Iron ore.* In some places 3′ to 4′; here,		2′ 0′
	Clay shale, bluish and greenish,		40′ 0″
	Balls of ore (good) in a course of		1′ 0″
	Clay shale and Black slate,		10′ 0″
	Sandstone,		3′ 0″
	Sandstone, hard, micaceous, shelly,		7′ 0″
	Red ore balls, (cold short,) in a course of		2′ 0″
	Sandstone, greenish,	10′ to	14′ 0″
	Red shale or marl,	40′ to	50′ 0″
	Maximum total,		258′ 0″
	Total of XI exhibited here,		122′ 0″

§ 172. "Crowning the highest part of the hills occurs a bed of conglomerate, 60 feet in thickness, less coarse than the main Pottsville conglomerate.

§ 173. "The *dip* of the strata at the mines on Stony run is gently westward: on Dutchman's run, on the opposite side it is towards the east-southeast, while a few miles further up the main branch of Stony run it is towards the northwest about 4°.

§ 174. *Peat.*—"A somewhat curious feature of this hill are the swamps occurring on its very summit; the largest occupying several acres, entirely destitute of timber, and containing a deposit of peat at least 15 feet in depth.

§ 175. "On *Red run* the strata are nearly the same as at Ralston. Beneath the conglomerate, the shale containing the iron ore is 34 feet thick, and underneath that is a sandstone 100 feet, succeeded by another bed of red shale. These two red shales correspond with those at Farrandsville, to be hereafter described, excepting that the iron ore occurs at the latter place in the lower bed.

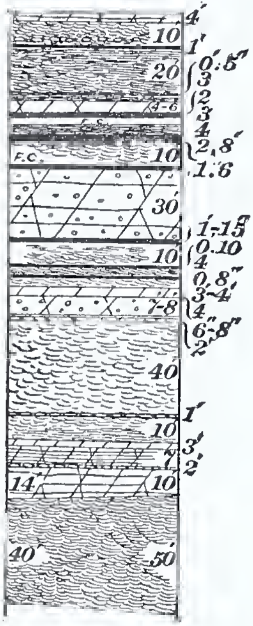
§ 176. "On *Dutchman's* run, a remarkable slide in the face of the hill has laid bare the [Catskill, Pocono and Pottsville conglomerate series.]

§ 177. *Astonville Section.* Section 17, Fig. 27.—"The following strata are displayed on the railroad between Astonville and the mines near Ralston:

XII	SANDSTONE, COARSE,	30′ 0″
	Coal bed,	1′ 4″ to 2′ 0″
	Fireclay,	5 0″
	Coal bed, Coal, Coal, bony, . . . 4 Coal,	2′ 0 to 2′ 6″
	Fireclay, Slate,	5 0″
	SANDSTONE, pebbly and coarse,	25 0″
	Coaly, bituminous slate,	2 0″
	Conglomerate (pea) and sandstone,	45′ 0″
XI	Shale, *red* and blue,	2′ to 3′ 0″
	Iron ore,	1′ to 2 0″
	Ball ore, in bluish shales,	2′ 0″
	Shale, blue,	30 0″
	Interval concealed,	100′ 0″
	CONGLOMERATE, white,	20 0″
	Sandstone, gray and greenish, coarse, often thick-bedded, obliquely laminated,	350′ 0″
	Shales, *red* and greenish, and Sandstone ferruginous, with lepidodendra,	85′ to 90 0″

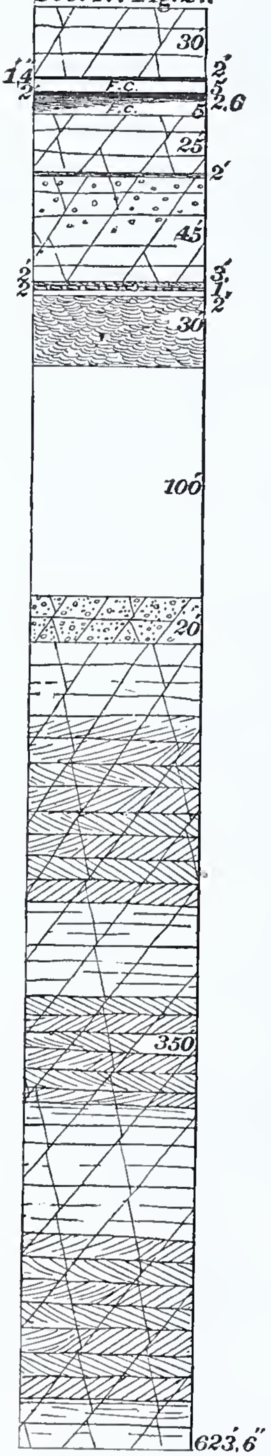
Ralston old mines.

Sec. 16. Fig. 26.



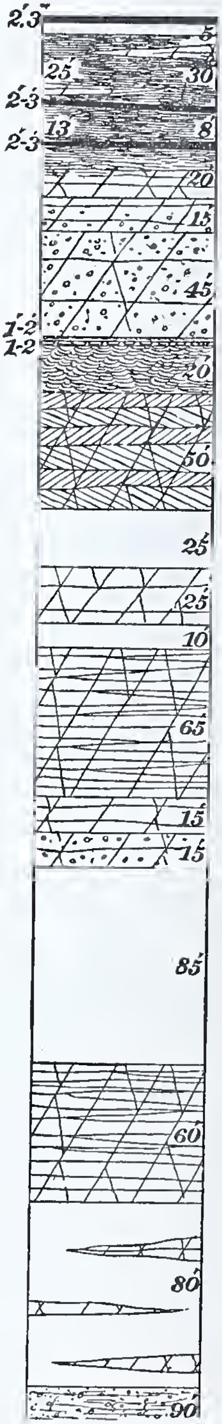
Astonville.

Sec. 17. Fig. 27.

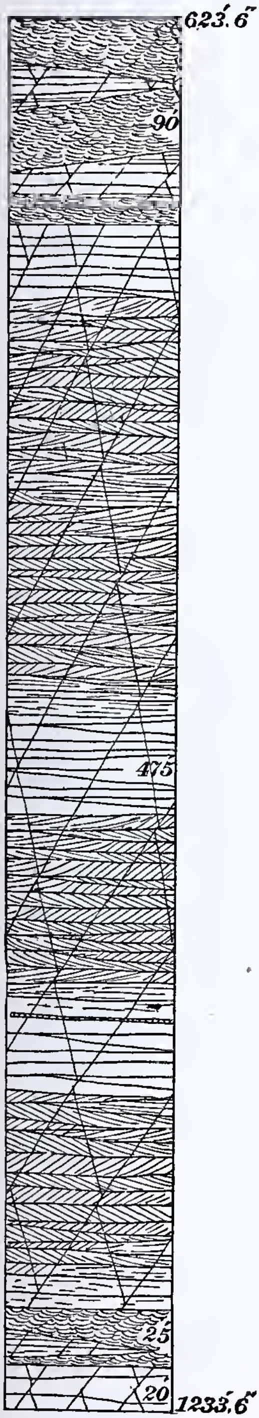


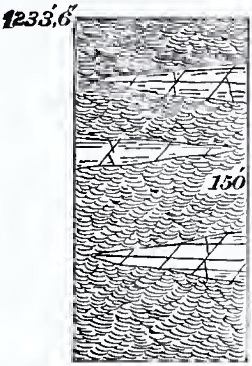
Cartersville.

Sec. 18. Fig. 28.



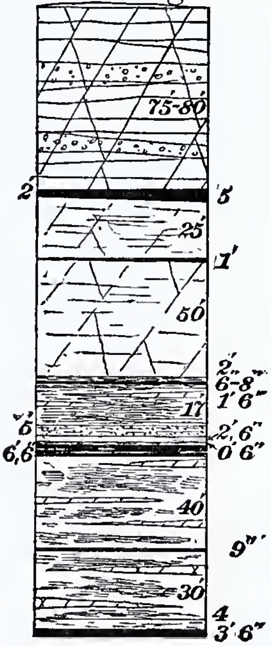
Astonville Section continued – Sec. 17. Fig. 27.





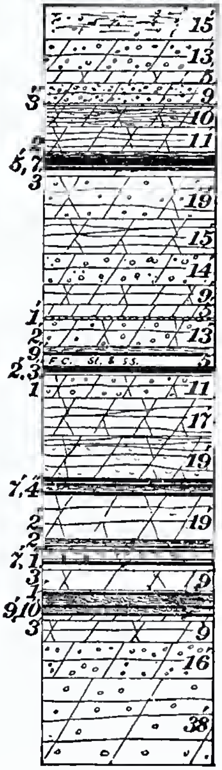
Red Run.

Sec. 20. Fig. 30.



Mc Intyre.

Sec. 19. Fig. 29.



X	Sandstone, flaggy, greenish, with Sandstone beds gray, and Slate beds blue; with a Calcareous, rotten breccia; in all visible,	475' 0"
IX	Sandstone, red and shale,	25' 0"
	Sandstone, green, with breccia,	20' 0"
	Shale, red, and sandstone to level of valley at furnace,	150' 0"
	Total,	1393' 6"

§ 178. "*The coal of the Astonville mines* is opened in several drifts. It is in two benches, the lower about 2 or 2½ feet; the upper from 16 inches to 2 feet. The fireclay between is 5 feet thick. In the lower coal about midway is a bony layer of 4 inches. Two drifts have been opened at an interval of about 300 yards. The coal is shot down steep slopes or inclined planes.

§ 179. "*The ore* is drifted on just under the conglomerate, which is pebbly in its lower layers, but a coarse, heavy-bedded pea-conglomerate for nearly 50 feet above this. The matrix of the ore is a fine bluish and red mottled argilaceous shale. The ore lies from 4 to 6 feet below the rock. It is a brown and grey carbonate in a bed, not concretionary, from one to two feet thick, but is now faulty and thin. Below the stratified ore, and nearly in contact with it, is a nodular ore of a concretionary form, and more ponderous. It also is a grey and brown carbonate. These nodules are irregularly placed at intervals in the shale. Below the level of the ore-drift the rocks are concealed for about 30 feet; but from the aspect of the surface I make no doubt this interval is occupied by shales. At 30 feet, a drift, mined for ore unsuccessfully, has brought to light bluish gray argillaceous shales, with some impressions of *Lepidodendron.* These shales are evidently somewhat calcareous.

§ 180. "Just south of the locality of the mines there is a deep ravine, in which a brook descends, and which, on account of the amount of the fallen conglomerate, shows no exposure except just below the bridge, where there is a mass of flaggy [Mauch Chunk-like] sandstone, included in the section. On the opposite or south side of the ravine, on the railroad, the first rocks to be seen are immense blocks of a very white pea-conglomerate, which has the appearance of dipping north, but which may be the [Pottsville] which has slipped down.

"A short distance south of this the rock is undoubtedly in place, and is here a coarse, thick bedded, light gray sandstone. The mass of this is not less than from 75 to 100 feet, and is succeeded, further south, by a more greenish and flaggy rock, but still generally coarse. Lithologically, these rocks present more clearly the characteristics of the [Pocono] Strata than any other, and as such we have chosen to regard them.

§ 181. "Directly behind the *Ralston House* at the foot of the hill, a crumbly red shale is seen underlying the heavy cliff of flaggy grey and greenish sandstone. Just at the top of this is a peculiar bluish-gray breccia, apparently calcareous, associated with an impure iron ore. This rock weathers very ragged and pitted, and is doubtless the same as that marked in the section as in the shales at the top of the [Catskill].

"As the rocks of the Ralston hill dip north, while those on the railroad for some miles north of Ralston dip south, Ralston must be on the south side of the synclinal, which includes the coal in the higher levels.

§ 182. "*Frozen run* enters Lycoming creek on the west side, below Stony run.

§ 183. *Furnaces.*—"There are two furnaces at Astonville, a small one using charcoal, which has been in operation successfully, and a complete furnace, 14 feet across the boshes, adapted to hot-blast. This was chilled in the first blast and is not now (1854) in operation. It was to use Anthracite mixed with the coal of the hill. The ore, when roasted, looks grey and vitreous. Three tons of ore are required to yield one ton of metal at the charcoal furnace.

§ 184. *Cartersville Section. Section* 18, Fig. 28, page 118.—"The strata in the hill at Cartersville, on Lycoming creek, one and a half miles above Ralston, are as follows:

	Coal bed,	2′ 3″
	Interval, said to contain kidney ore,	? ?
	Coal bed, slaty, not mined,	5′ 0″
	Slate and Sandstone,	25′ to 30′ 0″
	Coal bed, in one bench, good,	2′ to 3′ 0″
	Slate,	8′ to 13′ 0″
	Coal bed, good, harder than the one above,	2′ to 3′ 0″
XII	Slates passing down into Sandstone, slaty,	20′ 0″
	Sandstone, becoming pebbly downwards,	15′ 0″
	CONGLOMERATE, (pea) thick bedded,	45′ 0″
	Shale, bluish and *red,*	1′ to 2′ 0″
	Iron ore, shaly,	1′ to 2′ 6″
	Shales, red and blue, mottled, say	20′ 0″
	SANDSTONE, greenish, coarse, somewhat pebbly, micaceous, obliquely bedded, and containing vegetable impressions,	50′ 0″
	Interval concealed,	25′ 0″
	SANDSTONE, coarse, white; SANDSTONE, (lower beds,) pebbly,	25′ 0″
	Interval concealed,	10′ 0″
	SANDSTONE, coarse, thin bedded; impressions,	65′ 0″
	Sandstone, bluish, flaggy,	15′ 0″
	CONGLOMERATIC SANDSTONE,	15′ 0″
	Interval concealed,	85′ 0″
	Sandstone, bluish, olive, micaceous, flaggy, (in quarry,) some beds argillaceous, abounding in plant-casts,	60′ 0″
	Interval concealed, containing some Sandstone, micaceous,	80′ 0″
	Base of cliffs,	—
	A mass of shaly gravel intervenes between this and base of Umbral, (XI,)	90′ 0″
	Total of section,	660′ 9″

"There can be little doubt that the two lower seams at *Cartersville* are identical with those worked in the drifts of the Ralston Hill—the interval in the latter place having diminished.

"On the highest part of the Ralston hill, the upper or five-feet seam of Cartersville is said to have been found.

"At Cartersville there is a seven inch coal over the highest noted in our section.

§ 185. *Iron Ore.*—"At the latter locality, *ore* like that at Ralston is found, about eighty feet beneath the lowest coal. It lies in red and purple olive mottled shales, and, in general, is more argillaceous than the Astonville opening, though some masses are solid, containing white and brownish carbonate of iron. Its thickness varies from one foot to two feet six inches. There are two openings upon the bed, entering west by north. The more south of these has been driven but a few yards. The ore proved more shaly and impure than that of the other opening; the nodules are often crumbly shale, bluish and mottled purple, charged throughout with carbonate of iron. The average thickness of the bed in the two drifts is about eighteen inches.

§ 186. "The *furnace* at Cartersville is a very solid structure of the [Mauch Chunk] sandstone of the quarry; it measures twelve feet in the boshes.

§ 187. X. "The [Pocono] rocks, between Ralston and Cartersville, dip very gently west by north.

§ 188. IX. "On the railroad between Ralston and Canton there are, by estimation, from 550 to 600 feet of [Catskill sandstones and shales visible. Passing these, olive and reddish shales and flags may be seen to the thickness of 120 feet, full of fucoids, then fifty feet of heavy bedded, greenish sandstone, followed by reddish sandstone fifty feet thick, after which the road passes through seventy-five feet of red shales and greenish sandstones, and then olive and red sandy slate."

§ 189. The above are all the observations recorded by the First Survey, by the very able and conscientious geologist, whose camping party moved from place to place, forty years ago, through what was then an almost unbroken wilderness, in which little or nothing could be seen, except the main features of the geology, the general run of the basins, and what openings had been made at the one or two points of early operations in the Lycoming creek valley.

In making the examination of the McIntyre coal basin for the Report of the Second Geological Survey, a complete section of the Lower Productive Coal measures was obtained, with which the sections of the First Survey can be easily compared, and any inaccuracies or misconceptions in them detected, while their then careful measurements of the lower coal beds and ore deposits, now not so easily obtainable without reopening the old workings, are a very valuable contribution to this Report.

As to the measures below the Conglomerate, the recent examination has obtained sections of them which are not more specialized than the old ones above quoted, and which agree with them in the details with a very satisfactory nearness; except in the hypothetical location of the junction planes of XI–X and X–IX, as will be seen below.

§ 190. *McIntyre Section. Section 19, Fig. 29*, page 119.—Mr. Geo. H. Platt, chief engineer of the McIntyre Coal Company, at McIntyre, has made a complete and clean exposure of the whole section of *super-conglomerate rocks*, near the mines, as follows:

Earth,			15′ 0″
CONGLOMERATE, coarse,			13′ 0″
Sandstone,			5′ 0″
CONGLOMERATE, fine,			9′ 0″
Black slate,			0′ 3″
Sandstone,	Shaly, yellow,	10′	21′ 0″
	Flaggy, gray,	11′	
Slate, blue, *rich in plants,*			2′ 0″
Coal bed, E	Coal and bony coal,	1′ 6″	5′ 7″
	Coal,	3′ 0″	
	Bony coal and slate,	0′ 3″	
	Coal,	0′ 10″	
Fireclay,			3′ 0″
Sandstone,	Compact, white, conglomeratic,	19,	57′ 0″
	Coarse, brown,	15′	
	CONGLOMERATE,	14′	
	Coarse, white,	9′	
Sandstone, blue, (sometimes slate,)			5′ 0″
Ball ore stratum,			1′ 0″
Sandstone, coarse, gray, conglomeratic,			13′ 0″
Slate, dark blue,			2′ 0″
Coal bed,			0′ 9″
Fireclay, slate, and sandstone,			5′ 0″
Coal bed, D	Coal,	0′ 3″	2′ 3″
	Slate and bony coal,	0′ 6″	
	Coal,	0′ 4″	
	Slate and bony coal,	0′ 8″	
	Coal,	0′ 6″	
Fireclay,			1′ 0″
Sandstone,	Coarse, gray, conglomeratic,	11′	47′ 0″
	White,	17′	
	Shelly, dark gray,	19′	

Coal bed, C	Coal and bone,	1' 4"	7' 4"
	Slate, "sulphur stone,"	0' 4"	
	Coal, poor,	1' 0"	
	Slate and sandstone,	3' 6"	
	Coal, poor,	1' 2"	
Sandstone, brown, ore balls near base,			19' 0"
Black slate; *fossil plants*,			2' 0"
"Sulphur stone,"			0' 2"
Coal bed, B	Coal,	0' 10"	7' 1"
	Bony coal,	0' 3"	
	Coal,	0' 9"	
	Fireclay and slate,	2' 6"	
	Coal,	1' 0"	
	Slate,	0' 7"	
	Coal,	1' 2"	
Fireclay,			3' 0"
Sandstone, brown,			9' 0"
Slate,			1' 0"
Coal bed, A	Coal,	0' 9"	9' 10"
	Slate and shale mixed,	5 0"	
	Coal,	0' 9"	
	Shale,	3' 0"	
	Coal,	0 4"	
Sandstone,	Flaggy, dark,	3'	12' 0"
	Compact, white,	9'	
CONGLOMERATE,	Fine,	16'	54' 0"
	Coarse,	38'	
Total height of section,			332' 3"

§ 191. *Red Run Section.—Section 20, Fig. 30, page 119.*

On the west side of the Lycoming, the upper measures of the last given section are more completely exposed on Red run, thus (beginning at the top of the hill):

Sandstone mass, becoming CONGLOMERATE in places,			75' to 80' 0"
Coal bed E,			2' to 5' 0"
Interval concealed,			25' 0"
Coal bed D', small, sometimes as much as			1' 0"
Interval concealed,			50' 0"
Coal bed,	Black slate,	2' 0"	4' 2"
	Coal,	6" to 8"	
	Black slate,	1' 6"	
Slates and Sandstones, thin,			17' 0"
Slates,	Sandy slate,	5 0"	8' 0"
	Clay slates,	2' 6"	
	Black slate,	0' 6"	

Coal bed, D	Coal,	1′ 6″ to 1′ 8″	6′ 6″
	Black and gray clay slate,	3′ 6″	
	Coal,	0′ 3″	
	Black slate,	0′ 7″	
	Coal,	0′ 6″	
Slates and sandstones, in an *interval* of			40′ 0″
Coal bed C, small, rising to			0′ 9″
Slates and sandstones, in an *interval* of			30′ 0″
Clay slates.			
Coal bed, B	Black slate,	0′ 9″ to 1′ 0″	3′ 5″
	Coal,	0′ 5″ to 0′ 6″	
	Black slate,	0 2″ to 0′ 3″	
	Coal,	1′ 8″	
Total height of section,			270′ 8″

§ 192. The measures between coal bed B and the Conglomerate are not exposed on Red run. They probably agree with the McIntyre section.

The ores of XI are found as at McIntyre, underlying the Conglomerate, but of much greater thickness.

§ 193. *McIntyre Inclined Plane Sec.—Sec. 21, Fig. 31, p. 129.*

The measures underlying the Lower Productive Coal Measures are well exposed on the McIntyre plane and on the wagon road from the foot of the plane to McIntyre village, on the mountain top.

The coal which is at the top of this McIntyre plane section is the coal at the bottom of the McIntyre section, § 190 above. The two sections are, therefore, easily joined together, but are kept separate here, inasmuch as the former was leveled, while this section is by barometer; and also because the Coal Measure section is furnished by the McIntyre company, from their published statements, while the Inclined Plane section was made for this Report. It is as follows:

Soil,			10′ 0″
Slate, dark, ferruginous,			10′ 0″
Coal bed, small, *Bed A*,			0′ 6″
Slate, dark,			3′ 0″
XII.	Sandstone, massive, fine,	10′	70′ 0″
	CONGLOMERATE* sandstone, massive,	60′	

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* Pebbly; the pebbles, chiefly white quartz, of the size of peas.

XI.	Slates *red*, grayish, and ferruginous; holding some carbonate *ore masses;* and some regular one inch *ore layers;*	20'	75' 0"
	Iron ore layers, white carbonate, usually oxidized outside, in all about 2 feet; contained in a mass of shale,	5'	
	Slates, usually *reddish*, occasionally blood red; holding some nodules and small layers of *kidney ore*,	50	
X.	Sandstone, current bedded, thin bedded, greenish gray, micaceous; with a few shale streaks,	105'	655' 0"
	Black slate layers, with ore nodules,	10'	
	Sandstone, current bedded, gray, exposed sufficiently to characterize the interval,	40'	
	Sandstone, current bedded, gray, exposed sufficiently to characterize the interval: some shale layers also are noticeable, *Coal bed*, small, (1') 380'+ foot of plane.	420'	
	Foot of the plane.		
	Sandstone, current bedded, massive, Sandstone, thin bedded, (at Ralston,)	80'	
IX.	*Red slate*, shaly, soft,		15' 0"
	Total,		838' 6"

Although this *McIntyre plane section* is incomplete in some details, the characteristic features of the four principal formations, XII, XI, X and IX, and their separating planes, or limits, are sufficiently well displayed. By collating it with the previous *McIntyre mine section* we get the following:

§ 194. *Generalized McIntyre section. Fig. 32, page 129.*

XIII. Lower Productive Coal measures; measuring from the highest hill tops in the centre of the basin, down to the top of the massive conglomerate sandstone,	269'
XII. Pottsville Conglomerate, massive, with quartz pebbles the size of a pea,	70'
XI. Mauch Chunk Red measures, mostly soft, and holding valuable beds of carbonate iron ore,	75'
X. Pocono Sandstone, current bedded; called in Mr. Sherwood's notes *Gray Catskill*,	655'
IX. Catskill red sandstones and shales; several hundred feet thick; but only the top of it exhibited in the section,	15'
Total of measures thus studied,	1084'

While this McIntyre section agrees substantially with

Prof. Rogers' Centreville section on the opposite side of the Lycoming creek there are great differences of arrangement.

§ 195. The *Mauch Chunk Red Shale* formation is here limited to 75′. Prof. Rogers expands his *Umbral* (our *Mauch Chunk*) formation to 534′, by including 450′ of the underlying gray sandstone (Pocono) rocks. There is no difference in the order of the strata; nor has there been any such palæontological study of them as to justify on that ground either his expansion or our contraction of the limits of XI. But by confining XI to very narrow limits on Lycoming and Pine creeks, these sections become systematically more harmonious with the whole work of the Second Survey on the Susquehanna West Branch and further west and south. It is however freely admitted that fixed limits for such conformable but irregularly deposited (current bedded) sediments based upon lithological features. color, &c. must always be unconvincing.

In view of this, it may here be mentioned, that in the Barclay continuation (eastward) of this McIntyre basin there is a considerable thickness of XI underneath XII. In fact, the two or three hundred feet of rocks beneath XII are made up partly of deep red shales, and of shales interleaved with gray sandstones. It is very possible that some of the Barclay red shales are at McIntyre replaced by gray sandstones. Thus XI and X increase alternately, locally, at each other's expense, and yet without any change in the thickness of the whole column.

§ 196. *The Lower Productive Coal* measures at McIntyre take in some 270 feet in all from the highest rock exposed in the centre of the basin to the top of XII.

§ 197. *Mahoning Sandstone.*—The upper 60 to 65 feet include a sandstone, about half conglomerate, half flaggy and shaly yellow sandstone, with one small layer of black slate. The rock is coarse, massive, pebbly (large pebbles of white quartz,) and is a conspicuous feature of the mountain crest. Prof. Rogers considered it the equivalent of the *Mahoning Sandstone* of Western Pennsylvania, and there is no objection to that view of it.

It is found in just the same condition and with the same

Mc Intyre Inclined Plane. §. 193.

Sec.21. Fig 31

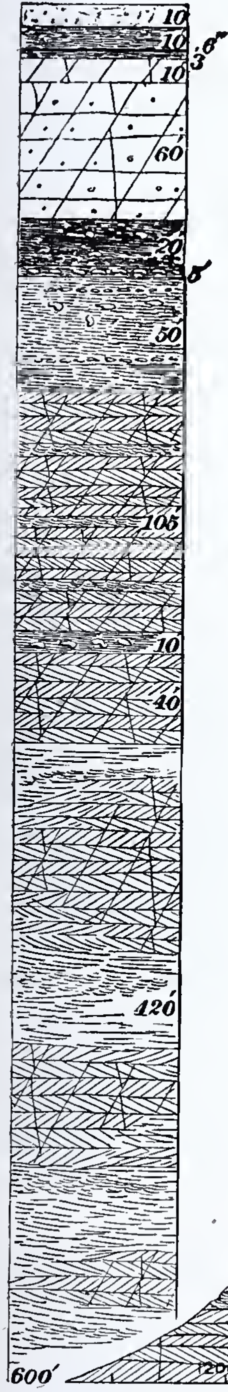


Fig.31.continued

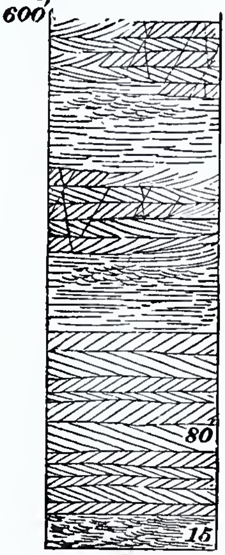
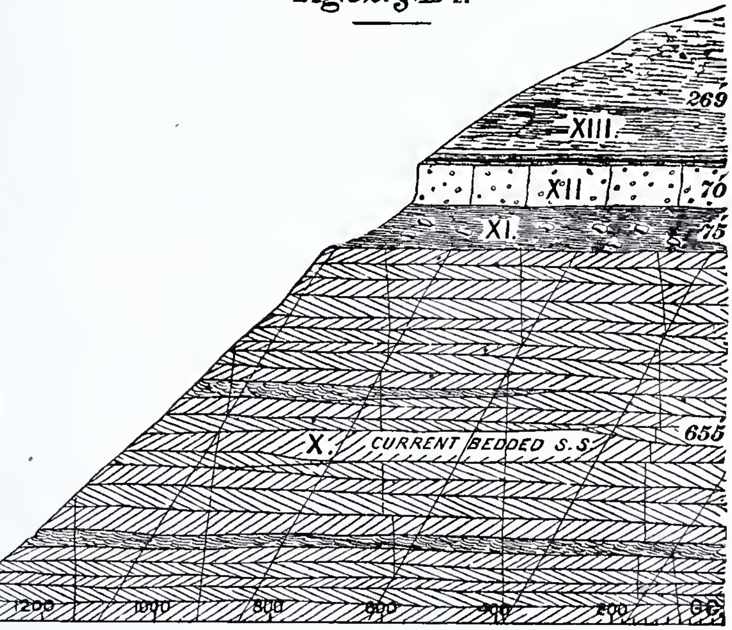


Diagram of the above.

Fig.32. §.194.



thickness on the waters of Red run, west of Lycoming creek: making there also a noticeable capping to the hill tops in the centre of the basin (counting the centre both from the ends and from the sides of the canoe shaped synclinal) and occupying therefore only a small area.

§ 198. *Coal E*, or the *McIntyre Coal bed*, lies beneath this (*Mahoning*) sandstone, only separated from it by two feet of black slate holding numerous fossil plants.*

It is opened in numerous places by the McIntyre Coal Company, which sends to market nearly 200.00 tons of its coal annually.

It varies widely in size even in the limited area already worked over by the McIntyre Coal Company. As measured in the mines it shows thus: Sec. 22, Fig. 33.

McIntyre Coal bed, E.		*Averaging.*
Coal and Bony Coal,	1′ 0″ to 2′ 0″	1′ 6″
Coal,	2′ 0″ to 4′ 0″	3′ 0′
Bony Coal and Slate,	0′ 0″ to 0′ 3″	0′ 3″
Coal,	0′ 6″ to 0′ 12″	0′ 10″
	3′ 6″ to 7′ 3′	5′ 7″

With a fireclay floor (2′ to 6′) and a black slate roof.

The actual merchantable coal to be won from the two benches is very variable. At the present time (June, 1879,) it is somewhat less than 3′, averaging perhaps not more than 2′ 8″. Considerable areas of the bed have however in the past averaged a greater thickness. Mr. Geo. H. Platt reports that one small area near the south-west outcrop on the A. Carson tract yielded nearly 7 feet of clean coal. At 2′ 8″ the basin is yielding of coal from this bed 4200 tons to the acre.

The coal is deep black, shining, and usually of handsome appearance. It breaks up very much in mining, and seems to make many light flakes which blow out from a locomotive stack unconsumed.

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* This bed is so widely known throughout all these regions as "Bed E" of McIntyre that the term is retained in speaking of it, without by any means claiming its identification with Bed E, [*Freeport Upper*) of the Allegheny mountain system. The probable relationship is discussed in another part of this report and the letters for the coal beds are used here merely for the convenience of those accustomed to them in our northern counties.

§ 199. *Analysis of a specimen from Drift No. 4.* (*E.*)

"The coal which is rather tender, has a deep black shining lustre, with seams of grayish black coal. The specimen shows but little iron pyrites.

Water,	1.170
Volatile matter,	17.120
Fixed carbon,	73.682
Sulphur,	.843
Ash,	7.185
	100.000
Coke, per cent.,	81.71
Color of ash,	Gray, with red tinge."

(A. S. McCreath.)

§ 200. *Analysis of a specimen from Drift No. 2.* (*E.*)

"The coal has a deep black glossy lustre, and is seamed with grayish black compact coal. It carries a few knife edges of slate and seems in the main free from iron pyrites.

Water,	.950
Volatile matter,	17.940
Fixed carbon,	71.151
Sulphur,	.834
Ash,	9.125
	100.000
Coke, per cent.,	81.11
Color of ash,	gray, with red tinge.

(A. S. McCreath.)

The ash of this coal was also analysed by Mr. McCreath, with the following result:

Silica,	47.585
Alumina,	40.117
Oxide of iron,	6.143
Titanic acid,	1.190
Lime,	.960
Magnesia,	.731
Sulphuric acid,	.932
Phosphoric acid,	.123
Alkalies,	1.486
	99.267

§ 201. *Analysis of a third specimen from bed E, McIntyre mines*, by J. M. Stinson, Mr. McCreath's assistant, in the laboratory at Harrisburg:

Water, at 225°,	.740
Volatile matter,	17.360
Fixed carbon,	78.153
Sulphur,	.567
Ash,	3.180
	100.000
Color of ash,	gray.
Coke, per cent.,	81.900
Fuel ratio,	1 : 4.50

§ 202. *Analysis of a fourth specimen of bed E, McIntyre mines*, by A. S. McCreath:

Water, at 225°,	.720
Volatile matter,	17.420
Fixed carbon,	78.106
Sulphur,	.564
Ash,	3.190
	100.000

Color, deep black; lustre, shining; generally free from slate and pyrites; seamed with charcoal.

§ 203. These analyses show that the coal from the McIntyre coal bed E belongs to the so-called *semi-bituminous* coals, the proportion of fixed carbons to volatile hydrocarbons being:

In the first specimen,	1 : 4.303
In the second specimen,	1 : 3.966
Average of two specimens,	1 : 4.134

§ 204. *East of the first branch* of Rocky run, there are no openings on bed E in the McIntyre basin. In fact it has never been shown that bed E catches on the hills at all east of the first branch; if it does so it must be in the extreme hill top, and cover a limited area. As it has never been found there, its condition is unknown, even if it be present on the hill crest.

§ 205. *On Red run, bed E* has been opened west of Lycoming creek. It has never been worked for shipment, but only to show the existence of the bed at that point, with its size and character. It occupies the same position with reference to the other coal beds of the measures as at McIntyre.

Interval between bed E and bed B, by barometer, 170′.

§ 206. *Butler opening, on bed E.*—Here seventy feet of rocks form the hill over the bed, made up apparently of sandstone and conglomerate, and the crest of the ridge is covered deep with scattered pieces of massive sandstone and conglomerate.

The coal is nearly on a level with the openings on bed E at McIntyre; but the centre of the basin has already been passed, and the rise of the coal is to the north. The openings are, therefore, about 970′ above Lycoming creek, at the foot of McIntyre plane, or about 1,870′ above ocean level.

The drift, now partially fallen shut, shows thus:—(Section 23, Fig. 34):

Clay slate in roof,	5′ 0″
Black slate,	1′ 0″ to 1′ 3″
Coal,	2′ 8″ to 3′ 0″
Floor not seen; apparently fireclay.	

The coal is all in one solid bench, without any regular slate partings that could be detected, the slate being in small, irregular, lenticular masses.

§ 207. *Analysis of bed E*, at *Butler opening*, *Red run*, *Lycoming county:*

Water, at 225°,	.950
Volatile matter,	16.235
Fixed carbon,	70.602
Sulphur,	.688
Ash,	11.525
	100.000
Color of ash,	gray, with pink tinge.
Coke, per cent.,	82.815
Fuel ratio,	1:4.35

Lustre dull; somewhat coated with iron oxide; generally very firm; partings of charcoal numerous. (A. S. McCreath.)

§ 208. The *Red Run Coal Company* have had numerous other openings made on coal bed E, at different places on their property, but they are now closed. It seems to have varied much in thickness. Mr. Coup reported it full 5½ feet thick at his opening, on the *south branch of Red run.* In other openings it was reported as showing 3′ to 3′ 5″ of clean coal.

§ 209. *Area of E.*—In the Red run region bed E covers considerable ground. It would require some very accurate topography and careful trial opening to determine just where the outcrop turned for its western limit; but a valuable basin of it is already clearly enough made out.

§ 210. *Interval Measures between beds E and D.*

The measures underlying coal E, in the McIntyre section, are entirely sandstone—usually massive—with some pebble conglomerate; and this continues for 80 feet or more down to coal bed D.

§ 211. *Coal D′.*—From some trial openings made on the *Red run*, there is reason to believe that a small 13″ coal bed comes in 30 feet below coal bed E. It has a roof of clay slate, holding iron ore balls, four or five feet in thickness, and a fireclay floor. It only appears, however, in one section on Red run.

§ 212. *Section on Red run.*—This section shows the existence of still another small coal bed between bed E and bed D, and only about 25 feet above D; embodied in black slate, and exhibiting only 6″ to 8″ of coal.

While, therefore, the McIntyre section shows only massive sandstones for 80 or 90 feet between E and D, the Red run section shows two intermediate small coals, one 25 and the other 65 feet above bed D; but they are both entirely valueless; and their absence from the McIntyre section either shows that they are of too local a nature to persist even across the small intervening distance between the sections; or, that they were not noticed in cutting roughly down across the more exclusively and massively sandstone interval at McIntyre.

§ 213. *Coal D* (Sec. 24, Fig. 35) appears in the McIntyre trial opening as a mass of coal and slate, thus:

				Average.
Coal,	6″	to	12″	0′ 9″
Fireclay, slate, and sandstone,	3′ 0″	to	7′ 0″	5′ 0″
Coal,	0′ 2″	to	0′ 4″	0′ 3″
Slate and *bony coal,*	0′ 4″	to	0′ 8″	0′ 6″
Coal,	0′ 3″	to	0′ 6″	0′ 4″

Slate and *bony coal*,	0' 6'' to 0' 10''	0' 8''
Coal,	0' 4'' to 0' 8''	0' 6
	5' 1'' to 11' 0''	8' 0''

With a fireclay floor of about 1 foot thick.

As it was only opened at McIntyre for measurement, no specimens could be procured for analysis.

§ 214. *On Red run*, also, bed D (Sec. 25, Fig. 36) is a mere mass of interleaved coal and slate layers. Here the run (main branch) has laid the bed bare, beautifully, about 90 feet (by barometer) below bed E.

Sandy slates,		5' 0'
Clay slates,		2' 6''
Black slate,		0' 6''
Coal,	D. 6' 6''	1' 6'' to 1' 8''
Black and gray clay slates,		3 6''
Coal,		0' 3''
Black slate,		0' 7''
Coal,		0' 6'
Slate in bottom,		—
		14' 6''

Here 2' 3'' of coal lie in 4' 1'' of slate.

Under the bottom slate there are 10 feet of sandy slate, and then sandstone.

§ 215. *Butler's D*, Sec. 26, Fig. 37.—Mr. Butler reports to the Red Run Coal Company that he opened the coal bed bed D and found it thus:

Coal,	0' 10''
Fireclay slates,	4 0
Coal, of splinty nature, and with a small slate parting near the top,	1 8
Black slate,	0 5
Bottom—Slate?	

Showing that the coal still retains at that opening its character of a mingled bed of coal and slate.

The coal itself exposed in the natural opening on Red run seems to be good and hard. It is possible that further development may find this bed sufficiently large and free from slate to make it of value; but the openings already made do not indicate it.

§ 216. *Area.*—Bed D ought to cover a large area in the McIntyre coal basin, both on the east and west sides of Lycoming creek.

§ 217. *Interval between D and C.*—Underlying coal bed D at McIntyre there are about 50 feet of massive sandstone, part of it a pebble conglomerate.

It is easily seen that in the McIntyre basin pebble rock ceases to be any guide at all in the measures, as it is found interleaved all through the Lower Productive Coal group.

On the *Red run* side of Lycoming creek the measures between D and C are chiefly thin bedded sandstones and an occasional layer of slates and slaty sandstone.

§ 218. *Coal bed C at McIntyre* was opened and measured thus, (Sec. 27, Fig. 38):

			Average.
Coal,	10″ to	18″	1′ 4″
"Sulphur slate,"	2″ to	6″	0 4
Coal,	9″ to	14″	1 0
Sandstone and slate,	3′ 0″ to	5′ 0″	3 6
Coal,	10 ′ to	16″	1 2
	5′ 9	9′ 6″	7′ 4″

Making in all some 3 feet of coal. But it does not average that size, nor do the size, the manner of interleaving with slate partings, and the character of the coal afford indications of a valuable bed.

§ 219. *On Red run* Mr. Coup reports to the Red Run Coal Company that he found "the coal bed C fully 12″ thick of coal, and with 79 feet of hill above it."

It is imperfectly exposed on the main branch of Red run, and is evidently a small bed of coal.

Whatever its size, taking the whole basin this bed must cover a large area.

§ 220. *Interval between C and B.*—Below coal bed C at McIntyre the measures are made up of a brown sandstone, about 20 feet thick, carrying iron ore balls in the lower portion.

Under it there is a 2 foot layer of black slate with *fossil plant* impressions.

In the Red run section the interval between Beds C and B is filled almost entirely with dark colored clay slates with some few layers of a thin bedded slaty sandstone.

§ 221. *Coal bed B* was for many years the only coal bed worked in the McIntyre basin. The old Ralston mines, the Red run openings, the Cartersville openings, &c., were all on coal bed B: and also the McIntyre and Robinson mines on Rocky run.

When the McIntyre compiled section was made, bed B measured (as stated in § 190) as follows, (Fig. 40, page 119):

		Averaging.
Coal,	0′ 8″ to 1′ 1″	0′ 10″
Bony Coal,	0 1 to 0 5	0 3
Coal,	0 7 to 1 0	0 9
Fireclay and slate,	2 0 to 5 0	2 6
Coal,	0 8 to 1 2	1 0
Slate,	0 2 to 0 9	0 7
Coal,	0 9 to 1 4	1 2
	4′ 11″ to 10′ 9″	7′ 1′

Or, over 3 feet of coal. But this is too high for an average.

§ 222. *The present new driving* on B at McIntyre has not yet got an average of full 2 feet of clean coal; nor any indication that three feet will be exceeded.

This new drift on B affords an example of the difficulty of judging of the value of any coal bed from a few openings. The heading is now (1879) some hundred yards in and measurements are given below: 1, at the starting point as soon as solid coal was reached; 2, 3, 4, at intervals of some hundreds of feet apart. See Sec. 31, Fig. 42.

1.	2.	3.	4.
Slate roof.	Slate roof.	Slate roof.	Same as No. 3: only the coal has gone down from 27″ to 21″.
"Sulphur," . 4½″	Sulphur, . . . 4″	Sulphur, . . . 2″	
Coal, ... 4″	*Coal,* . . . . . 4″	*Coal,* . . . . . 25″	
Bone, ... 1½″	Bone, ... 2″	Fireclay, . . . 12″	
Coal, ... 18″	*Coal,* . . . . . 17″	*Coal,* . . . . . 1″	
Stone, ... 8″	Bone, ... 3″	Rock, ... 4″	
Bone, ... 2½′	Fireclay, . . . 3″	*Coal,* . . . . . 2″	
Stone, ... 5″	Bone, ... 3″	Bone coal and badly mixed, 9″	
Coal, . . . 2½″	*Coal,* . . . . . 1″	Rock, ... 3″	
Stone, ... 3″	Bone, ... 7″	*Coal,* . . . . . 7″	
Coal, ... 1″	*Coal,* . . . . . 4″	Rock floor.	
Bone, ... 4″	Bone, ... 6″	Changed to no sulphur and coal to 27″.	
Coal, ... 2½″	*Coal,* . . . . . 7″		
Stone, ... 6′	Rock floor.		
Coal, ... 7′			
Rock floor.			
Starting in drift.	Jan. 14, 1879.	March 1, 1879.	June 1, 1879.

§ 223. The statistics of the old mines of McIntyre and Robinson on Rocky run have already been given in the extract quoted from the Report of 1858 (§ 168 above.) These mines certainly never had B averaging full 3 feet of clean coal.

§ 224. *Bed B* is reported to have been opened on Hound run and on the branches of Rocky run, east of Hound run. The coal bed certainly passes through all that region and could easily be found and developed. The openings however are all very old, and have long since fallen shut.

On the west side of Lycoming creek there have been numerous openings and workings on B. Such of the facts concerning these openings as were obtainable in 1854 have already been quoted from the Report of 1858, § 171, above.

§ 225. *The old Astonville Coal mines* on B are on the south and west side of *Red run*, 1 mile west from Ralston; 845′ (by barometer) above the railroad track at Ralston, or about 1712′ above the ocean level.

The *iron ore of XI* was worked directly below them, and taken by tram road around the mountain side to the Astonville furnace at the mouth of Frozen run.

The *old drifts on B*, now entirely fallen shut, were headed south, and evidently drained the coal rising in that direction. The hill rises 70 feet above the coal opening affording abundance of cover. A great mass of bone-coal and slate-refuse lies at the mouth of the mines: and as but little coal was shipped, the slate and bone partings must have been heavy.

But though there is a 70 foot hill, in spite of this amount of cover, the area of coal must be small, for the rise of the coal to the south is decided at this point, and the crest between Red run and Frozen run is here narrow. The broad spread of the coal area is further up Red run.

§ 226. *The Red run mines*, on B, were opened on the main branch of Red run, by the Red Run Coal Company, and have been long since abandoned. They had a plane, and "shipped in 1854, 1855, and 1856, at least 20,000 tons." The details about this work have been already quoted in § 175, above.

These old mines on Red run are now nearly entirely closed. A measurement, as obtained in one old drift, showed:

Clay slates,	4′ 0″
Black slate,	0′ 9″ to 1′ 0″
Coal,	0′ 5″ to 0′ 6″
Black slate,	0′ 2″ to 0′ 3″
Coal,	1′ 8″
Floor not seen.	

This makes only two feet of coal in all.

The bed seems to have averaged some three feet in thickness, always in two benches. The company report that the bed showed in places:

Coal,	1′ 8″
Slate parting,	3′ 0″
Coal,	2′ 6″ to 3′ 0″

But this is evidently above any average yield of the bed.

The following analysis of the coal from bed B, at the *old Red run mines*, is furnished by the company, thus:

Fixed carbon,	76.469
Volatile matter,	9.011
Ash,	13.470
Sulphur,	.048
Water,	1.002
	100.000

There must certainly be some error in the analysis as returned by the chemist, Dr. James R. Chilton. The proportion of volatile hydro-carbon is low enough for an anthracite or semi-anthracite coal.

There is probably a clerical error of 9.011 for 19.011 for the volatile hydro-carbons; and 76.469 instead of 66.469 for the fixed carbon. With these corrections the analysis would represent the average condition of coal B.

A specimen of the coal from the *new opening* on B, at McIntyre, was forwarded to Mr. McCreath, and yielded the following analysis:

Water, at 225°,	0.510
Volatile matter,	16.860
Fixed carbon,	63.898
Sulphur,	.782
Ash,	17.950
	100.000

Color of ash,	gray.
Coke, per cent.,	82.630
Fuel ratio,	1:3.79
Specific gravity,	1.440

"Dull black; generally free from pyrites; carries numerous bands of slaty coal."

§ 227. *The Cartersville mines*, on bed B, were opened on the mountain on the west side of Lycoming creek, for the Cartersville furnace. Some 2,000 tons of coal were removed in all, but none of it used at the furnace.

A specimen of the coal from the *old Carter opening, on B*, yielded, to Mr. McCreath's analysis:

Water, at 225°,	1.220
Volatile matter,	15.825
Fixed carbon,	72.474
Sulphur,	.636
Ash,	9.845
	100.000
Color of ash,	gray.
Coke, per cent.,	82.955
Fuel ratio,	1:4.58

A specimen of the coal from *the old Red run mines, on B*, yielded, to Mr. McCreath's analysis:

Water, at 225°,	.730
Volatile matter,	16.930
Fixed carbon,	74.116
Sulphur,	.677
Ash,	7.547
	100.000
Color of ash,	gray.
Coke, per cent.,	82.34
Fuel ratio,	1:4.38

"Deep black; iridescent; rather tender; somewhat coated with iron oxide."

The company is reported to have worked only the lower bench, and found it average 2 feet 9 inches of clean coal.

§ 228. *Locomotive coal test.*—The Red Run Company furnish the following record of a test of coal from bed B, mined at the Red run mines, on locomotives, dated August 1, 1864:

"By instructions from Mr. Bowen, resident engineer, engine No. 68, (Jeremiah Burns, engineer, and E. C. McCormick, fireman,) made a number of trial trips from Elmira to Williamsport, using coal from Red run mines. They report:

"We find it makes more steam with a less quantity of coal, burns clearer, makes no clinker, and is entirely free from sulphur or any deleterious substance; and would recommend it as equal to if not superior, as a fuel for locomotives, to any coal we have ever used."

These locomotive tests, when fairly made and reported, are valuable evidence of the steam-raising power of a coal.

§ 229. *The area of bed B* in the McIntyre coal basin is very great; and this bed is really the most important factor in the future history of the coal trade of this region.

§ 230. *The level above tide* of the old Red run mines is only 1667′. The old Astonville mines, on the same bed, B, are 1712′. This shows the shape of the basin, and the average slope of the bed between these two places.

§ 231. *Measures between B and A.*—Underlying coal bed B there is a bed of fireclay at McIntyre, three feet thick; and under this a layer of massive brown sandstone, from 7 to 11 feet thick.

§ 232. *Coal bed A.*—Directly under this brown sandstone comes in coal A, showing a section at McIntyre, thus:

			Average.
Slate,	6″	to 2′ 0″	1′ 0″
Coal,	6″	to 1′ 0″	0′ 9″
Slate and shale mixed,	4′ 0″	to 7′ 0″	5′ 0″
Coal,	0′ 6″	to 1′ 0″	0′ 9″
Shale,	2′ 0″	to 4′ 0″	3′ 0″
Coal,	0′ 2″	to 0′ 6″	0′ 4″
	7 8″	to 15′ 6″	10 10″

The bed is entirely worthless, being made up of thin layers of coal between thick layers of slate. In fact it does not hold anything like this thickness of coal. At the cutting at the top of the plane the total measurement of coal has diminished to less than six inches. Practically A may be dismissed from consideration; for it is nowhere opened in the basin now; and there has never been grounds for expecting it to prove workable; except a report that it was once struck in a well on Red run mountain, and was there three feet thick.

§ 233. *The Pottsville Conglomerate.*—Directly below bed A comes the conglomerate, varying somewhat in its upper member. The best exposure is at the incline plane, where it consists of

Fine-grained, massive sandstone, ...	10′ 0″
Pea conglomerate, very massive, with pebbles of white quartz, ...	60′ 0″

The McIntyre section shows only 56 feet instead of 70, as here. It occupies a great area in the McIntyre basin; and so far as seen seems to keep both its thickness and its character, as given above. Its area, indeed, is far greater than its mere outcrop indicates; for it rises high on its outcrop, and spreads out over a broad plateau, at least 2,200 feet above the ocean level.

The ice movement being to the southward, and the slope of the surface being also southward, everything for miles south of the north outcrop of XII is covered up with its massive fragments, which are found lying even on top of measures which are geologically above it in the series. In all the northern counties where the glacial ice has shown its power, the transportation of blocks of XII from their proper places at the outcrops has been the fruitful parent of many errors.

This is the case where masses of XII are seen covering the bottom slopes of mountains, the summits of which are capped by X.

An opposite kind of deception is produced by finding blocks of XII, (as in the northern part of the McIntyre basin,) stranded on some high ridge composed of coal measure rocks, XIII.

§ 234. *The Mauch Chunk red shale.*—The red rocks of XI, (Rogers' Umbral,) come in as red clay and fireclay directly under the Conglomerate of XII. Their mode of occurrence, thickness, &c., has already been given in the

McIntyre plane vertical section, (in § 193,) and more fully in quotations from the Final Report of 1858.

§ 235. *The iron ores of XI* were being mined for the furnaces at the time the work was done for the First Geological Survey, and the measurements there given are more accurate and complete than can now be obtained at the abandoned mines.

§ 236. *At the McIntyre plane*, is the best exposure at present. Here, in December of 1872, the Red Run Coal Company employed Frederick Butler to uncover and measure them. His report was as follows:

White iron ore, mixed with fireclay,	—
Shale,	10' 0"
Red ore, in balls,	3' 6
Shale,	8 0"
Red ore,	3 0"
Red shale,	20 0"
Fireclay,	12' 0"
Rock,	—

From present appearance this would seem to be an exaggeration of the thickness of the solid ore.

§ 237. *On the Red run side of Lycoming creek* the Red Run Company report that the white ore yielded them three to four feet of iron ore. No ore at all can be seen there now.

§ 238. *At the old Carterville* Furnace mines, now fallen in, a specimen was taken from a pile of it lying at the mine mouth, for analysis by Mr. McCreath, and proved to be a good ore, holding an unusually low percentage of both phosphorus and sulphur.

"Ore exceedingly hard and tough, fine-grained; crust hematitic. Fresh fracture glistens with small scales of mica. Color generally reddish gray."

Metallic iron,	31.000
Metallic manganese,	.288
Sulphur,	trace.
Phosphorus,	.075
Alumina,	1.004
Lime,	1.250
Magnesia,	1.549
Insoluble residue,	28.770

§ 239. *White ore.—The old Astonville charcoal furnace* ran for many years on these ores of XI, an analysis of which (white ore) was made as early as 1830, by W. W. Mather, at West Point, N. Y., resulting as follows:

Carbonic acid,	27.47
Carbon,	1.52
Water,	1.50
Silica,	14.50
Alumina,	6.80
Protoxide of iron, with traee of manganese,	47.64
Lime,	0.01
Sulphuric acid,	trace.
Loss,	0.56
	100.00

Metallic iron, 37.05 per cent.

This *white ore of XI* was analysed again in 1873, by James Damant, at Williamsport, Pa., and yielded 36 per cent. of metallic iron, no other constituents being recorded.

§ 240. *The iron ores of XI*, along Lycoming creek, in the McIntyre coal basin, were known at an early date, and their value fully appreciated and somewhat overrated.

§ 241. Iron making was started at the *old Astonville furnace*, on Lycoming creek, at the mouth of Frozen run, about 1837, using the white carbonate ore of XI, charcoal as fuel, and a cold blast. The furnace made good metal, and the enterprise was a success for a number of years. The following testimony to the grade of metal made, is given by J. & J. Essington, owners of the Crescent iron mill, on Lycoming creek, and dated November 16, 1840:

"We have made a satisfactory trial of the pig iron made from the white or gray ore made at the Lycoming Valley Iron Company's furnace, on Frozen run, and are perfectly satisfied that the bar iron made from it is equal in quality, if not superior, to any manufactured in this State."

The *old Astonville furnace* blew out about 1847.

§ 242. The Lycoming Iron Company bought out Lieb, Martin & Co., and erected the *new furnace at Astonville*, which blew in in 1853, and chilled.

In 1864 Messrs. Langdon and Albright blew in again on anthracite coal, using only a small quantity of the ore of

XI, as a mixture. Since the flood of 1865, when the furnace blew out, it has remained idle.

It will be noted that the first charcoal furnace history was a success; that the second anthracite furnace history was disastrous throughout.

§ 243. *The small abandoned furnace* near the railroad track at Astonville, was first blown in in 1855, by William Thompson, of New York, on the white ore of XI, and charcoal. It never worked well, remained in blast only five or six months, and has stood idle ever since.

§ 244. *Cartersville furnace*—on Lycoming creek; 2½ miles south of Roaring branch; 3½ miles north of the old Astonville furnace; 1½ miles north of Ralston and near the foot of McIntyre plane; on the property of the Red Run Coal Company; was built by Mr. Carter, of Tamaqua.

The stack was finished in 1854, but stood until 1874 before it was put in blast by Mr. Williams, of Minersville. It was blown from May 20, 1874, to July 20, 1874, and never again.

It used about 500 tons of the white ore of XI mixed with ore from New York State. The fuel was anthracite.

Taken altogether the record of iron making from the iron ores of XI in this Astonville region would have been one of disaster, except for the original charcoal furnace which used these native ores unmixed.

The anthracite stacks used only a small part of native ores of XI, and relied chiefly on the "Mansfield" ores of VIII in Bradford county or on the fossil ore of V from Clinton county, New York, both of these ores being as a rule lean and sandy. The flux was brought by rail from the Williamsport region, and the anthracite fuel reached the stacks from a long distance off. Hence disaster in every trial.

Summary of the foregoing details.

§ 245. *The McIntyre Coal measures* in the hills between the second and third branches of Rocky run, only extend 3 or 3½ miles to the east-north-east of the village.

The coal area lies north of the main stream of Rocky run, and of the third (or southern) branch of it.

A small coal area may also lie south of Rocky run just at the forks of the second and third branches.

§ 246. Starting in on the hills between the second and third branches of Rocky run: coal measures cover all the hill tops to the north of Rocky run, and westward to Lycoming creek; their southern limit being the hills on the north side of Rocky run; and their northern limit equally well defined by *McIntyre mountain*, a ridge of Conglomerate, rising to 2200′, its bold crest being the divide between the waters of Rocky run and Lycoming creek. This long straight mountain of XII becomes in Bradford county the *Towanda mountain*, the northern limit of the Barclay Coal basin.

§ 247. The loss of acreage of coal area by numerous valleys of erosion in the eastern half of the McIntyre basin is very great, because the coal beds lie so near the hill tops.

The uppermost bed, E, underlies a very small area.

The lower bed, B, underlies nearly all of the country within the outcrops of the Conglomerate, a very considerable area; easily accessible on Coal run, on the first branch, on Hound run, and on the second branch of Rocky run. Its coals can be brought down to the Lycoming creek cheaply.

It cannot be many years before a knowledge of the existence of a regular bed of assured value (as to quality of coal) will cause the lands of the basin to be rated as workable coal property even if the bed may not average quite up to 3 feet; and there seems every reason for believing that between 2½ and 3 feet of coal can be obtained from it; although it is always parted, and requires a large handling of waste stuff.

§ 248. West of Lycoming creek, the McIntyre basin has a higher value and a brighter future, although the main and branch valleys of Red run and Frozen run cut up this western half as badly as those of Rocky run cut up the eastern half of the basin.

The lower coals catch on the hill tops between Red run and Frozen run, along the south side of the basin.

McIntyre mountain may be said to cross the Lycoming and with the same high straight crest (2200 feet above the ocean) marks the north edge of the basin at the head waters of Red run and Frozen run.

The basin extends west from Lycoming creek to a point in Jackson township 6 or 7 miles west of McIntyre.

The uppermost (McIntyre) bed, E, underlies several hundred acres. The exact amount cannot be stated for want of special contoured maps.

The lower beds have been opened at various times.

Bed B, all told, covers a very large area. The numerous old openings on it go to show that between 2½ and 3 feet of coal can be obtained from it in the Red run region, but always at the expense of handling a great deal of waste and exercising much care in getting rid of sulphur slate.

The whole region however possesses a considerable value for future production.

§ 249. At present the entire *product of coal* is mined from bed E, and at the McIntyre mines alone; no other mines being in operation.

§ 250. *No faults.*—So far as the exposures of rock in place, or coal openings, sufficed to determine, the McIntyre coal basin, along its whole length from the eastern to the western end of the broad pointed canoe-shaped synclinal, is singularly *free from all faults*, important cross rolls, or variations in the measures themselves.

§ 251. *Regularity.*—One complete vertical section seems to apply with great regularity to the whole basin: and the reported sudden changes of measures in point of distances between coal beds, or disturbances of ordinary horizontality, are found to spring from some misidentification of the coal beds, misconception of the structure, or errors in leveling. In the underground workings moreover everything has been regular and smooth.

§ 252. *Dips.*—On its south side the beds leave the basin on a gentle rise.

A brecciated calcareous rock, noticeable in appearance, shows at Ralston some 35 to 40 feet above the creek: this rock reaches railroad level between Ralston and McIntyre plane: and must pass some 40 feet below R. R. level at McIntyre plane. As the foot of the plane is some 35 feet above Ralston, more or less, the actual rise for this mile is not more than 40 feet. But from that southward the rise becomes at once sharper.

On the north side the basin is steeper, and the rise to the north is already very considerable at McIntyre, working as they do there from the centre of the synclinal axis.

§ 253. *Markets.*—The geographical position of the McIntyre basin, and its proximity to the great market for steam raising coals afforded by central and western New York, is what gives the value to the basin. Twenty-four miles (via the Northern Central railroad) puts the coal at Williamsport, on the Philadelphia and Erie R. R. Fifty miles (via the Northern Central R. R.) puts the coal at Elmira, on the New York, Lake Erie, and Western R. R. and in connection with the whole railroad system of central New York.

In the presence of the large Clearfield county coal bed at Houtzdale, or the big bed of Cumberland, these McIntyre beds would not count of much value. Large beds, indeed, lie entirely unheeded in Clearfield and Somerset counties. But it is doubtful whether the richest coal land of western Pennsylvania produces more pecuniary profit to the owner and shipper than these smaller coal-bed lands of the detached basins of northern Pennsylvania.

For the chief market supplied by these northern basins there is no competition with either Clearfield county or the Cumberland basin of Maryland; their competition is simply with each other.

Into such competition the McIntyre basin enters with a reasonable chance of success.

The Barclay basin is working its Barclay coal bed, B, with from 2½ to 3 feet of average thickness. The Bloss bed of the Blossburg basin is down to about that thickness over much of the coal area; and the northern basins of McKean county are shipping from a coal bed of just about the same size.

There is little reason to doubt that the future will see extensive shipments from this basin, increasing *pari passu* with those of the neighboring coal fields.

The total shipments from the McIntyre coal basin have not been great.

The old mines on coal bed B may have shipped in all 40,000 to 50,000 tons.

The McIntyre mines, since they opened at McIntyre, have shipped about one and a half million tons.

§ 254. *Coke from McIntyre Coal.*—Some of the McIntyre Coal was rudely coked, in the open air, for the purpose of testing its coking qualities.

Mr. McCreath thus described the sample forwarded to the Laboratory for examination:—

"Coke from unwashed coal; shows numerous lenticular masses of slate; lustre dull; structure generally rather dense; but the coke seems comparatively easily crushed."

By analysis:

Water at 225°,	.405
Volatile matter,	.891
Fixed carbon,	89.123
Sulphur,	.689
Ash,	8.892
	100.000

Chapter VII.

Mansfield ore in Lycoming county.

§ 255. Fossiliferous beds of iron ore, lying among Chemung strata, in the upper part of Formation VIII, have been long known and mined in the neighborhood of Mansfield in Tioga county.

These ore beds are described in Report of Progress G, on Bradford and Tioga counties; analyses are given to exhibit their character; and sections to show their place in the series of the rocks.

What seem to be the same beds, or beds of like character, holding the same relative geological position in the column of formations, were recognized by Mr. Sherwood in the foot hills of the Allegheny escarpment, along the north side of the Williamsport valley, in Lycoming county. The beds are steep and their outcrop runs in a continuous, although somewhat irregular, crenulated line from west to east across Pine creek and Lycoming creek.

§ 256. The ore is of much the same character as in Tioga county. It is always fossiliferous, carrying many *fish teeth:* is usually reddish brown in color, sometimes grayish; and lies in reddish and purple slates, with some gray clay slate layers.

§ 257. The *Hayes ore mine*, on Lycoming creek, and Northern Central railroad, one third of a mile north of Cogan station, was opened and worked for the furnaces at Danville, but is now (1879) closed.

The bed dips steeply to the north and is reported to have shown from 2 to 4 feet of ore in all.

An average specimen was obtained, and analysed by Mr. McCreath, who reported thus:

"The ore is rather coarse grained, and highly fossiliferous; it carries numerous *phosphatie pebbles.* Color, reddish brown and reddish gray."

Sesquioxide of iron,	49.857
Sesquioxide of manganese,	.248
Alumina,	3.774
Lime,	6.270
Magnesia,	1.693
Sulphuric acid,	trace.
Phosphoric acid,	1.759
Carbonic acid,	2.590
Water,	4.060
Insoluble residue,	29.130
	99.381
Metallic iron,	34.900
Metallic manganese,	.173
Sulphur,	trace.
Phosphorus,	.768

§ 258. *Quiggleville mine.*—The same bed has been extensively worked at Quiggleville, one mile northwest of Perryville in Lycoming township, just south of Mr. Stiber's house, and shipped to furnaces on the Susquehanna river.

Here the bed has an average dip of only 6° to 8°) towards the north) and lies in red and purple slates with some clay layers gray colored.

A specimen was analyzed by Mr. McCreath, who reported thus:—

"Rather compact and fine grained ore; fossiliferous; with some *phosphatic pebbles.** Color, reddish brown."

Sesquioxide of iron,	46.643
Sesquioxide of manganese,	.300
Alumina,	5.476
Lime,	1.760
Magnesia,	1.030
Sulphuric acid,	trace.
Phosphoric acid,	1.101
Carbonic acid,	none.
Water,	4.310
Insoluble residue,	39.220
	99.840

Metallic iron,	32.650
Metallic manganese,	.209
Sulphur,	trace.
Phosphorus,	.481

§ 259. *The McGowan mine*, on Stewart's run, 2 miles northeast of Jersey Shore, in Piatt township, was worked for the use of furnaces on the Susquehanna river.

A specimen of the ore was forwarded to the Laboratory of the Survey, and analysed by A. S. McCreath:

"Ore generally compact; highly fossiliferous; with some phosphatic pebbles. Color, reddish brown."

Sesquioxide of iron,	40.714
Sesquioxide of manganese,	.103
Alumina,	5.269
Lime,	1.620
Magnesia,	.828
Sulphuric acid,	trace.
Phosphoric acid,	.907
Carbonic acid,	none.

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*One of these *phosphatic pebbles* (coprolites?) in the Hayes iron ore yielded to an analysis by J. M. Stinson, in the Laboratory at Harrisburg:

Oxide of iron and alumina,	35.429
Lime,	34.247
Magnesia,	.360
Phosphoric acid,	26.242
Loss on ignition,	3.156
Insoluble residue,	.566

Water,	3.710
Insoluble residue,	46.630
	99.781
Metallic iron,	28.500
Metallic manganese,	.072
Sulphur,	trace.
Phosphorus,	.396

§ 260. *Furnace run mines.*—On the north side of Furnace run, close to the south line of Watson township, and near the old Safe Harbor furnace, are some abandoned workings, from which a specimen of ore was selected, and analysed by Mr. McCreath, who reported thus:

"Ore rather fine-grained; fossiliferous; shaly; reddish brown in color."

Sesquioxide of iron,	42.857
Sesquioxide of manganese,	.186
Alumina,	4.690
Lime,	1.450
Magnesia,	.881
Sulphuric acid,	trace.
Phosphoric acid,	.863
Carbonic acid,	none.
Water,	3.705
Insoluble residue,	44.830
	99.462
Metallic iron,	30.000
Metallic manganese,	.130
Sulphur,	trace.
Phosphorus,	.377

There is no record of the exact thickness of the iron ore bed on Furnace run. It was stripped along the outcrop quite extensively, and supplied Safe Harbor furnace for many years. The ore is dipping gently to the north.

To show the quality of iron made from this ore by Safe Harbor furnace, a bolt manufactured at the rolling mill attached to the furnace, was analysed by Mr. McCreath, who reported it to contain:

Silicon,	1.311
Sulphur,	0.024
Phosphorus,	1.458
Manganese,	0.202

§ 261. The analyses given in the above detail are grouped below in a table, in order to show the character of the ores as compared with each other, and for convenient comparison with other ores.

These analyses show that this Chemung fossil ore, in its run through Lycoming county, carries sufficient phosphoric acid to injure its value materially, as the demand for cold short ores has much fallen off in these last five years.

The relative quantity of iron in the ore is not high; and there is not much prospect at present of extensive mining on these ores.

Sesquioxide of iron,	49.857	46.643	40.714	42.857
Sesquioxide of manganese,	.248	.300	.103	.186
Alumina,	3.774	5.476	5.269	4.690
Lime,	6.270	1.760	1.620	1.450
Magnesia,	1.693	1.030	.828	.881
Sulphuric acid,	trace.	trace.	trace.	trace.
Phosphoric acid,	1.759	1.101	.907	.863
Carbonic acid,	2.590	none.	none.	none.
Water,	4.060	4.310	3.710	3.705
Insoluble residue,	29.130	39.220	46.630	44.830
	99.381	99.840	99.781	99.462
Metallic iron,	34.900	32.650	28.500	30.000
Metallic manganese,	173	.209	.072	.130
Sulphur,	trace.	trace.	trace.	trace.
Phosphorus,	.768	.481	.396	.377

CHAPTER VIII.

Fossil ore in Lycoming County.

§ 262. The Clinton fossil ore of Formation V, outcrops along the north slope of the Bald Eagle mountain, around its eastern end, and around the edge of White Deer valley.

§ 263. *Along Bald Eagle mountain.*—The double crest of the mountain being made of vertical rocks of IV, the measures of V (Clinton) have an unbroken run of many miles along its northern slope.

Only one ore bed in the group is worked: and the workings extend along a line of only about two miles on the face of the mountain at Antes Fort opposite Jersey Shore. Elsewhere along the mountain little prospecting has been done, and that little unsuccessfully.

§ 264. *Young's.*—The fossil ore bed was examined on

Young's place, on the south side of the Susquehanna river, near Antes Fort, opposite Jersey Shore and 2 miles south of it.

The mine has been worked recently.

The ore is reported as varying somewhat in thickness, but always lying in three layers which average:

Upper layer,	ore,	0′ 3″
Middle layer,	ore,	0 4″
Lower layer,	ore,	0 8′

The ore is a block ore and works out easily.

Samples were made from each of the three beds 1. upper, 2. middle, 3. lower, and Mr. McCreath's descriptions are as follows:

1. Ore, compact, fine grained, sandy, with lenticular masses of slate; color, reddish brown.

2. Ore, compact, fine grained, sandy, with numerous shot-like phosphatic pebbles.

3. Ore of the same general appearance as the last.

	1.	2.	3.
Sesquioxide of iron,	30.000	42.857	43.928
Sesquioxide of manganese,	.145	.248	.300
Alumina,	5.051	5.975	4.568
Lime,	1.100	1.720	1.300
Magnesia,	1.116	1.037	1.000
Sulphuric acid,	.015	.022	.005
Phosphoric acid,	.439	.868	.694
Carbonic acid,	1.277	1.289	1.075
Water,	2.773	3.971	3.925
Insoluble residue,	58.120	41.980	42.570
	100.036	99.967	99.365
Metallic iron,	21.000	30.000	30.750
Metallic manganese,	.101	.173	.209
Sulphur,	.006	.009	.002
Phosphorus,	.192	.379	.303

§ 265. In *White Deer valley*, no fossil ore has been mined, and only one trial drift has been put in upon the outcrop; and this only developed a lean, ferriferous, laminated, yellowish brown shale, analysing 19.20 iron, and 61.25 insoluble residue; consequently quite worthless.

CHAPTER IX.

Lewistown Limestone in Lycoming county.

§ 266. The limestones of Lower Helderberg age, Formation No. VI, are described in great detail, in Report of Progress F, on the Juniata district, in which they have a great development, with many ranges of outcrops, cut by numerous streams into natural rock sections.

The principal member of the group is 215 feet thick at McVeytown, and 185 at Lewistown, whence its name.* But the whole interval of interleaved massive limestones, cement beds and calcareous shales and marls, lying between the Oriskany sandstone (VII) above, and the Clinton red shales (V) below is *at Lewistown* 1227 feet, and at *Lock Haven* 895 feet.

§ 267. An outcrop of these limestone rocks of various grades, pure and impure, massive and shaly, about a quarter of a mile wide, dipping north and northwest, follows the whole course of Bald Eagle creek and the Susquehanna west branch, from Altoona in Blair county, past Lock Haven in Clinton county, and Williamsport, to and beyond Muncy in Lycoming county.

This outcrop is crossed and recrossed by the numerous horseshoe bends of the Susquehanna river, and seldom makes any notable mark on the surface of the valley, being more or less dissolved away and excavated, often far below the present river level, and covered with alluvial deposits.

When the foot slopes of the Bald Eagle valley extend themselves into the valley in the larger bends of the river, the limestone rises somewhat upon them, and forms part of the mountain. But when the river bends cut deeply into the mountain slope, the limestones are left in the bends on the opposite side, north of the river.

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*The New York name of the group was taken from the Helderberg mountain bordering the Mohawk valley on the south.

§ 268. *Limestone quarries.*—The burning of lime for agricultural purposes or for plastering is an industry of some consequence in the valley of the Susquehanna.

The *Lewistown limestone* furnishes the stone quarries, and is worked throughout the valley, from the mouth of Pine creek, in the west end of the county, all the way round into White Deer valley.

The localization of these quarries, the larger part of all the work being confined to a few localities, contrasts strangely with the continuous and regular belt of outcrop shown on the geological map of the county, and is due to the fact that an article so cheap as limestone can only be worked to a profit at points where it can be quarried in large quantities, at the least expense.

Along the whole long run of the limestone belt through Lycoming county, these favorable circumstances occur at but few places.

§ 269. *Near the mouth of Pine creek* the limestone is well situated for quarrying, and free from cover; and is, therefore, largely burned for lime in that locality.

East of Pine creek the limestone outcrop sinks beneath the loose débris in the valley.

About 1½ miles *west of Montoursville*, where it is in place to quarry cheaply, there are extensive quarries and kilns.

To the east of this again favorable locations are utilized.

In White Deer valley the stone is burned only along a ridge for four miles, when it comes close to the surface and needs little or no stripping.

For all practical purposes the lime kiln industry is as rigorously bound to locality as though the limestone existed in pot form instead of as a great formation with a wide, continuous outcrop across the county.

Analyses of Limestone.

§ 270. A specimen of the limestone from *Bailey's quarry*, near the mouth of Pine creek, was forwarded to the Laboratory of the Survey, in Harrisburg, and yielded to analysis by Mr. McCreath, as follows:

"Limestone fine-grained; light bluish gray in color; hard and brittle, with conchoidal fracture."

Carbonate of lime,	72.156
Carbonate of magnesia,	20.304
Oxide of iron and alumina,	1.600
Sulphur,	.167
Phosphorus,	.005
Insoluble residue,	5.570
	99.802

A specimen of the limestone from *Ferguson's quarry*, one half mile away, proved even more dolomitic, showing nearly 31 per cent. of carbonate of magnesia. Mr. McCreath reports it thus:

"Limestone very compact and fine-grained; light bluish gray in color; mottled with calcite; hard and brittle."

Carbonate of lime,	60.964
Carbonate of magnesia,	30.691
Oxide of iron and alumina,	1.330
Sulphur,	.100
Phosphorus,	.003
Insoluble residue,	6.960
	100.048

On the *Wilson place*, just back of Jersey Shore, is an outcrop of limestone, not yet quarried, from which a specimen was sent to the laboratory at Harrisburg, and Mr. McCreath reports it thus:

"Limestone, fine-grained; bluish gray in color; comparatively soft; argillaceous.

Carbonate of lime,	70.589
Carbonate of magnesia,	1.740
Oxide of iron and alumina,	4.660
Sulphur,	.027
Phosphorus,	trace.
Insoluble residue,	21.680
	98.696

At *Fred. Hoerner's quarry*, two miles west of Montoursville, the limestone is extensively quarried and burned; is massive, deep blue in color, and dips 12° to the north; lies favorably for mining, and needs little stripping; 100′ of beds visible, and about 45′ quarried. The formation appears to be more than 200′ thick, but is not easily measured.

Some rotten red sandy clay rocks (of V) underlying the limestone, show at the north end of the Montoursville bridge over the Loyalsock creek, dipping north, 14°.

There are other quarries and kilns in the vicinity of Hoerner's, and he estimates that they burn together some 200,000 bushels of lime annually.

Considerable limestone is burned *east of Montoursville*, a few miles from Muncy.

The quarries and kilns in *White Deer valley* have already been described in the township details, § 100, 103, 104, pp. 72, *et seq.*

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§ 271. *Small coal area on Hoagland's run.*

In Mr. Sherwood's report he states that there is no coal in Cogan House township. This is true so far as any practical working of coal is concerned: but there are a few acres of coal caught on the crest of a narrow high ridge, on Hoagland's run.

Some little coal was mined out a number of years ago and hauled to Crescent station on the Northern Central railroad for use in the Crescent iron works; but the coal mine has been long abandoned.

Mr. McCreath reports the character of the coal as follows:

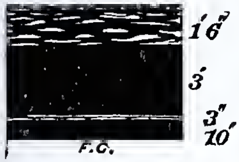
The coal has a dull black lustre, is rather firm and compact, and seems in the main free from pyrites.

Water @ 225°,	1.510
Volatile matter,	16.780
Fixed carbon,	68.814
Sulphur,	.621
Ash,	12.275
Color of ash,	gray.
Coke, per cent.,	81.710
Fuel ratio,	1:4.10

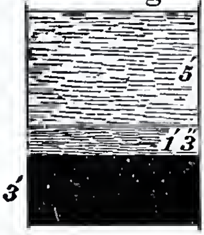
The quality of the coke is decidedly inferior and the dry coal seems to re-absorb water very rapidly.

Coal Bed E.

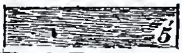
McIntyre. §190. §198.
Sec. 22. Fig. 33.



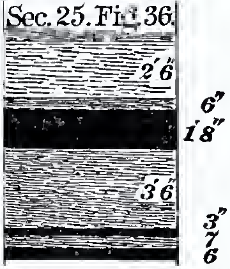
Butler's Opening §206.
Sec. 23. Fig. 34.



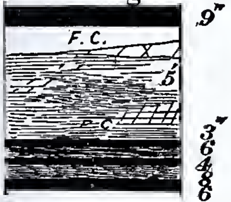
Coal Bed D. & D'.



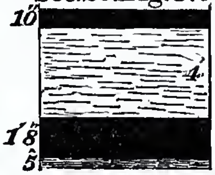
Red Run §214.
Sec. 25. Fig. 36.



McIntyre. §190. §213.
Sec. 24. Fig. 35.

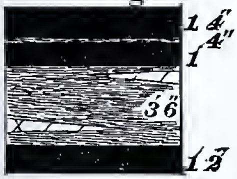


Butler's Opening §215
Sec. 26. Fig. 37.

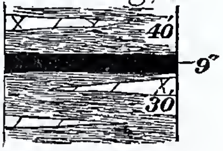


Coal Bed C.

McIntyre. §190. §218
Sec. 27. Fig. 38

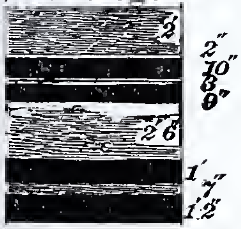


§191.
Sec. 28. Fig. 39.

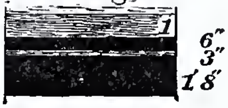


Coal Bed B.

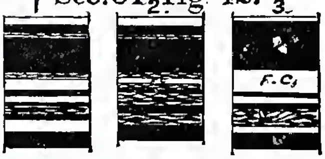
McIntyre. §190. §221.
Sec. 29. Fig. 40



§191. §222.
Sec. 30. Fig. 41.

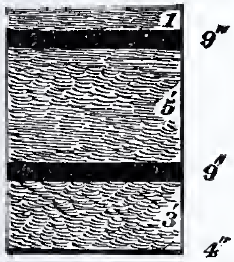


New McIntyre drift. §222.
Sec. 31. Fig. 42.



Coal Bed A.

McIntyre §190. §232.
Sec. 32. Fig. 43.



GG.

PART SECOND.

REPORT OF THE PROGRESS
OF THE
SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA,
IN
SULLIVAN COUNTY.

By FRANKLIN PLATT.*

CHAPTER I.

General Geology of the County.

§ 272. Sullivan county borders Lycoming county on the east, and is surrounded by Bradford on the north, Wyoming and Luzerne on the east, and Columbia on the southeast.

In shape it is a somewhat irregular parallelogram, with the southwest corner cut off; its area, as given by Gray and Walling, being 433 square miles, or 275,200 acres; and its townships are arranged in the following order:—

FOX. ELKLAND.
FORKS. CHERRY.
HILLSGROVE. COLLEY.
LAPORTE.
SHREWSBURY.
DAVIDSON.

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* The field notes of Mr. Sherwood have been used.

It was incorporated from Lycoming county March 15, 1847.* Its population in 1860 was 5,637; and in 1870, 6,191. Their habitations and farms are chiefly to be found along the narrow valleys of Muncy creek and the numerous branches of the Loyalsock. The mountain plateaus, entirely unsettled, are still covered with the primeval forest and visited only by hunters and lumbermen. The reasons for the wildness of Sullivan county, and for its small increase of population, will be revealed by the following description of its geological structure.

§ 273. *The drainage* of the county is very simple in its character.

Muncy creek heads up on the north or Allegheny mountain plateau in the northern part of Davidson township, then runs westward, making the boundary line between Davidson and Laporte townships, and where it leaves the county making the boundary line between Davidson and Shrewsbury townships. The rainfall of eastern and southern Shrewsbury drains into Muncy creek.

Fishing creek, by its east and west branches, drains the southern and eastern part of Davidson township.

Loyalsock creek, with its branches, drains nearly all of Sullivan county. This broad and deep stream has its head waters on the high lands in the extreme eastern part of the county, in Colley township. After receiving in Colley the water from *Lopez creek*, *Pigeon creek*, *Rocky run* and other branches, which reach far back into the mountains and drain a great area, the Loyalsock flows a general westerly course through the northern part of Laporte township and the southern part of Forks township.

Little Loyalsock creek joins the main stream at Forksville. This large affluent heads up in the northeast corner of Cherry township, and flows on a general westerly course through Cherry and Forks townships, before joining the Loyalsock.

From Forksville the Loyalsock flows west and southwest, making the boundary between Forks and Elkland; enters

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* The county seat, Laporte, was laid out in 1850.

Hillsgrove and runs south and southwest across it; and leaves the county at the southwest corner of the township.

Elk creek.—In the northern part of Hillsgrove the Loyalsock receives the waters of Elk creek: a large stream draining nearly all Elkland and Fox townships.

Mehoopany creek drains the northern part of Cherry and Colley townships, eastward, into the Susquehanna river.

Schroeder branch of Towanda creek and *Rocky run*, a branch of Lycoming creek, head up together in the high lands of the northwest corner of Fox township.

All these main streams flow in deep and narrow cañon like valleys, walled in by steep slopes and almost vertical cliffs; and in these walls, varying in height from five hundred to a thousand feet, open a thousand ravines, set with water-falls, through which issues the rain-fall of the general table land above.

The difference of level between the uplands and creek bottoms will be best seen from tables 82 and 92 *b* in Report of Progress N, pages 82 and 92, 93.

1. On the State Line and Sullivan railroad from Towanda to Bernice.*

		Above ocean.
Monroeton junction,		762′
Wilcox,	7 miles,	1,123′
New Albany,	9 "	1,197′
Miller's,	11 "	1,330′
Dushore,	16 "	1,593′
Bernice,	24 "	1,858′

2. Bench marks &c. furnished by Mr. Mason, of Laporte, August, 1873; corrected by reference to datum established by Mr. Ames at Nanticoke, (538.09′ above mean surface of Atlantic ocean) June 27, 1877.

	Above ocean.
Loyalsock creek, at the turnpike bridge,	1,650′
Junction of "Lee road" and the turnpike,	2,284′
Turnpike in front of Long pond hotel,	2,318′
Hilltop east of Long pond,	2,383′
Junction of "Mud pond road" and pike,	2,258′
Mud pond road, at outlet of Long pond,	2,192′
Old Hammer mill, Sickler's branch,	2,185′

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* From the only record that could be obtained.

On ridge 800 feet east of the mill,	2,238′
Crossing of Bowman's creek,	2,004′
Forks of Bowman's creek,	1,923′
Bench on Hemlock, 200′ below forks,	1,905′
Bench on Beech, Phillip's creek notch,	1,920′
Phillip's creek, road crosses, foot of Mountain,	1,247′
Nanticoke, on the Susquehanna river, R. R. grade,	538′

§ 274. *Structure*—It is a geological law that a region never exhibits a system of water courses like those above described, and also exhibited on the map of Sullivan county, (colored by Mr. Sherwood) accompanying this volume, unless its rock formations are spread out horizontally, or nearly so.

The *Allegheny mountain plateau* of Northern Pennsylvania, taken as a whole, is such a region; and Sullivan county shares its topographical features with Wyoming on the one side and Lycoming, Tioga, Potter, Northern Clinton, &c. on the other, because like theirs its own rocks are slightly inclined northward and southward from the axes of two principal anticlinals, towards the trough between them, and toward the two troughs outside of them. The following provisional names, will serve for convenient designations commencing at the north:—

The Barclay McIntyre synclinal, at the north.
The Wilmot anticlinal.
The Mahoopeny synclinal.
The Muncy creek anticlinal.
The North Mountain synclinal, at the south.

But it must not be supposed that these broad flattened rock waves are perfectly regular. They have subordinate undulations, and are steeper in some parts than in others. But the dips are universally so gentle, and the country so wild, that it is impossible to trace the crests of the anticlinal waves, or the axes of the basins between them, across the map, with any precision. All that can be said with certainty is, 1. that the northwest corner of Sullivan county is nearly in the middle line of the Barclay coal basin of Bradford county; 2. that the great Wilmot anticlinal (described in Report of Progress G, on Bradford county) passes Campbellville in Elkland township; 3. that the next great trough to the south is that which holds the Bernice coal basin; 4. that the next great anticlinal to the south follows the valley of Muncy creek; and 5. that the North mountain occupies another great trough in the extreme southern part of the county.

Mr. Sherwood has described an intermediate anticlinal passing Shunk in Fox township.

Rose valley, also, in Lycoming county is excavated in the broad back of an anticlinal which enters Sullivan county at Hillsgrove, and seems to split the Bernice trough into two (for an uncertain distance eastwards) so that perhaps we ought to speak of the *Bernice trough* and the *Laporte trough.*

Whether the Wilmot anticlinal runs through (westward) into Rose valley, or dies away in Fox township; and whether the Muncy valley anticlinal dies away in Wyoming county, letting the Bernice and the North mountain synclinals become one trough (the Tunkhannock or Elk mountain synclinal on the Susquehanna river,) is not clear, and could be settled only after long and expensive special topographical surveys.

Neither is it easy to see whether or not the Muncy valley anticlinal changes its W. S. W. direction at Tivoli P. O. (in Shrewsbury township, Lycoming county) and becomes the sharp steep anticlinal which runs at the foot of the Allegheny mountain from Tivoli, first N. 85° W. to Loyalsock village, then, due west to Perryville (on Lycoming creek) and then W. S. W. to Pine creek behind Short mountain. Its broad gentle form seems to make it belong to a different system of flexures.

With these reservations it may be proper to describe the anticlinals and synclinals of Sullivan county thus, *commencing at the most southern*, and taking them in order northwards.

§ 275. *The North mountain synclinal** enters Sullivan from the southwest corner of Wyoming county, as a broad, high, densely wooded wilderness plateau† destitute of coal,

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* "Short mountain," "Hepburn," "Elk mountain" synclinal.

† The highest summits are about 2500′ above tide.

(the southern edge of which looks down upon the lowlands of Montour,) filling up all the space between Muncy creek and the Lycoming county line; and therefore the central line or axis of the trough cannot be definitely drawn upon the map.

§ 276. *The Muncy creek anticlinal*[*] follows the valley of that creek, which has been excavated in the Catskill rocks, elevated along this line. It issues upon the low country somewhere near Tivoli P. O. and seems to join the east end of the Hepburn anticlinal described in the report on Lycoming county.

The line of the axis of the anticlinal runs somewhere through the wilderness of central and southern Colley; but can be more definitely located where it crosses the Susquehanna and Tioga turnpike and enters the southeastern part of Laporte. Along this part of its course it traverses a high plateau, rugged with masses of conglomerate and sandstone, and covered with an almost unbroken forest.

In Davidson township, Muncy creek heads up near the axis of the arch, and follows it closely southwestward into Lycoming county. The valley is well cultivated, its side slopes showing the soil of the soft red Catskill rocks.

§ 277. The *Mahoopeny* double *synclinal*[†] occupies the broad mountain country north of Muncy creek in Colley, northern Laporte, southern Cherry, Shrewsbury and Hillsgrove townships.

It is divided into two sub-troughs (Bernice on the north; Laporte on the south) by a gentle anticlinal which makes its appearance on the turnpike,[‡] and is probably the dying eastern end of the anticlinal of Rose valley in Lycoming county.

The whole plateau is a rugged wilderness, penetrated by a few wood roads and foot trails, and the rock-dips are comparatively gentle; so that the shape of the two troughs could only be defined by a long, elaborate and very expensive survey, without a prospect of discovering anything valuable.

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[*] "Tunkhannock" anticlinal.

[†] "Waterville, Loyalsock and Bernice" synclinal.

[‡] A mile or more south of Loyalsock creek near the old Schreifogel tavern.

The only useful mineral in the county (within reach from the surface) is coal, and the coal is confined to the centre line of the northern or Bernice trough; chiefly at Bernice in Cherry township; but also in a hill top in southern Forks township. Both will be described in following pages.*

It is of course possible that the two troughs may be dimpled. There may be more than one sub-dividing arch of the rocks. But these will be local irregularities not affecting the integrity of the double synclinal.†

§ 278. *The Wilmot anticlinal* of Bradford county may be so drawn on the map as that its axis will enter Sullivan county half way between Dushore and New Lancaster, *i. e.* just where the Sullivan and Erie railroad crosses the county line; thence, through or just south of Campbellsville: and so on to the Lycoming county line.

In Bradford county this grand anticlinal makes broad cultivated lowlands of Chemung rocks; bordered by a rolling hill country of Catskill rocks; in turn walled in by escarpments of Pocono and Pottsville conglomerate supporting the mountain plateau. A bay of Catskill country, surrounded by mountains, fills up much of Elkland township; the wall of Pocono rock closing round it to west through Fox and into McIntyre township (Lycoming county.)

There is therefore a cleared and cultivated Chemung and Catskill open country in northern Forks and Cherry and eastern Elkland townships. But all the rest is steep mountain slope, sharp ravines, or rocky plateaux, over which spreads an unbroken wilderness of trees, with here and there a swamp or pond of water. Bear, deer and rattlesnakes are the only inhabitants. This however, is no more true of this part of Sullivan, than of most parts of Lycoming, nearly all of Potter, and much of Tioga counties. Wyoming county is in the same condition on the east.

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*Of course, at many thousands of feet beneath the beds of the valleys, lie the limestones and fossil iron ores of the Chemung, Upper and Lower Helderberg and Clinton formations; quite out of reach of all mining operations.

†The name Mahoopeny was applied to this synclinal mountain mass by Mr. J. T. Hodge, and was adopted as the name of the coal basin, until the settlement of Bernice.

The Wilmot anticlinal, declining or dying down westward, passes into or under a sort of broad bridge of this plateau, which joins the Bernice basin with the Barclay McIntyre basin, (the eastern end of the *First Basin* of western Pennsylvania.)

§ 279. *The Barclay synclinal* (of the Towanda mountains) has its southern edge overlooking this bay on the north in the extreme northwest corner of Sullivan county.

The connection of these anticlinal and synclinal waves with those described in the preceding report on Lycoming county must be studied from the colored maps accompanying this volume.

Character of the Townships.

§ 280. *Davidson township*, occupies the southeast corner of Sullivan, on the Allegheny (North) mountain plateau, about 2000′ above the sea, unsettled, wooded, rocky, ravined. The Susquehanna and Tioga turnpike makes its east border line. The only other road ascends the mountain by Fishing creek (west branch,) follows Painter's creek to the divide, and descends on the Muncy creek settlements. That part of the township in the Muncy creek valley is cultivated; the soft red Catskill rocks furnishing a smooth surface and deep but not very rich soil.

§ 281. *Colley township* occupies the whole eastern border (nearly one sixth) of Sullivan county. It lies 2000′ above tide; is densely wooded and entirely uncultivated, except in a few small clearings in the bottoms of the Loyalsock and Mahoopeny creeks. The ravines of the Loyalsock furrow the township; but not to a depth sufficient for showing the red Catskill rocks. But in the deep valley of the Mahoopeny at the northern end of the township these rocks are exposed.

Long pond (Ganoga lake) drains, not west into the Lycoming, nor north into the Mahoopeny, but southeast into Kitchen creek by a series of superb cascades, through a chasm, with perpendicular cliff walls, affording rare scenery.

This is a favorite hunting ground for the citizens of eastern Pennsylvania, and should be a favorite haunt of landscape painters.

The *Muncy creek anticlinal* merely elevates the table land without breaking it as in Davidson township.

The *Bernice coal basin* points out eastward on the plateau, east of Pigeon creek; see the following chapter.

The rest of the surface of the township is composed of Pocono gray sandstone rocks, overlying Catskill red sandstone, as will be shown in sections below.

§ 282. *Laporte township.* The southern border of this township shares with Davidson the cultivated valley of Muncy creek. A few settlements have been made in the Loyalsock valley at its northern border. A few clearings have been made in the forest which covers the intermediate plateau.

Laporte, near the west line, is the county seat of Sullivan.

Here, the southern flat sub-basin is just deep enough to contain the bottom layers of the *Pottsville conglomerate.*

All the rest of the high land of the township is faced with Pocono; allowing the outcropping edges of the underlying Catskill to appear only in the deeper ravines, and in the valleys of Muncy and Loyalsock creeks.

A coal bed has been opened (and worked a little) in the northwest corner of the township, as will be related further on in the following chapter.

§ 283. *Cherry township*, stretching along the Bradford county line, west of Colley, and north of Laporte, is the best cultivated and most populous township in Sullivan; the farms which work *Chemung* soil are confined to the northwest corner; but a broad belt of red *Catskill* soil extends southward to the slope of the Pocono sandstone outcrop through the middle of the township.

Its southern half is a high plateau of Pocono, Mauch Chunk and Pottsville formations, supporting coal measures; all forest covered, and very rough.

The Bernice coal basin occupies the summit of the dividing ridge between Birch creek and the Loyalsock, and will be described in detail in the next chapter.

Dushore on Little Loyalsock creek is the largest town in Sullivan county.

§ 284. *Forks township*, next west of Cherry, was named from the branching of the Loyalsock at Forksville, and is well cultivated along the county line, where the Wilmot anticlinal brings up the Chemung rocks and spreads them over the smooth rolling surface. The red Catskill soil is also cultivated as far south as the high land of Pocono sandstone.

The *Bernice synclinal axis* passes through the southern part, south of Forksville, where a small area of the lowest coal bed has been preserved, as described further on.

The southern half of the township, therefore, may be described as a badly broken table-land of sandstone and conglomerate cliffs and fragments, entirely unsettled and uncultivable.

§ 285. *Shrewsbury township* covers the area west of Laporte and Davidson; between these townships and the Lycoming county line.

The Muncy creek anticlinal at its southern corner, brings up soft red Catskill rocks and a cultivated soil.

All north of this is high rocky surface, covered with forest, penetrated by deep narrow ravines and cañon-like gorges, separating narrow steep hog-back mountains, capped with upper Pocono sandstone strata, and bestrewn with thickly scattered blocks and masses of broken Pottsville conglomerate.

The Bernice coal trough passes through the northern end of the township, but no coal has been mined or even opened in it.

§ 286. *Hillsgrove township*, west of Shrewsbury, along the Lycoming county line, is a high mountain plateau of Pocono sandstone, split in two by the deep valley of Loyalsock creek, in the north and south walls of which outcrop the Catskill red rocks. These side walls are broken by numerous side valleys and ravines, all of them cutting down through the Pocono into the Catskill, and making the whole township rugged and wild. The forest is scarcely broken by a clearing except along the valley bottoms.

But in the northwestern part of the township the Rose Valley anticlinal of Lycoming county spreads out an area of lower hill country of Catskill rocks, the soil of which has been brought under considerable cultivation.

The Laporte synclinal passes through the southern part, but no coal measures have been preserved in it.

§ 287. *Elkland township* extends from the Loyalsock creek and Hillsgrove northwards to the Bradford county line (between Forks on the east and Fox on the west) across the high forest-covered mountain plateau of the Bernice synclinal; down the slope of the Pocono and Catskill outcrops; and across the low lands of Chemung soil brought up by the Wilmot anticlinal. All these are well cleared and cultivated. But the Bear mountain region in the southern part of the township is still wild, broken and forest-covered.

§ 288. *Fox township* occupies the northwest corner of Sullivan county, between Lycoming and Bradford.

The Wilmot anticlinal coming from the eastward in Elkland township dies down in Fox township in a sort of amphitheatre of the gray Catskill rocks circling to the north, south, and west of the red Catskill rocks, brought up by the anticlinal axis.

These red Catskill rocks are the country rock around Fox Centre, and this region is cleared and cultivated.

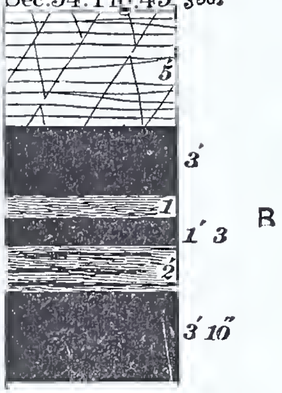
The balance of the township is covered by gray Catskill rocks, and is rugged and mountainous.

§ 289. The Pocono, Catskill, and Chemung formations appear in their several areas in Sullivan county, with characters so like those displayed in Lycoming county, that the reader is referred to the preceding report, with its detailed sections made along the Lycoming creek and elsewhere. No such sections could be constructed with the means at our disposal in Sullivan county, and the only mineral wealth to justify such sections consists in the beds of coal next to be described.

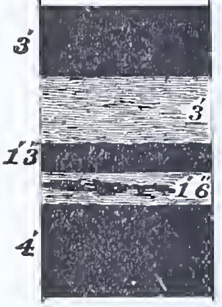
Sections in the Bernice Basin

Sullivan County
Pennsylvania.

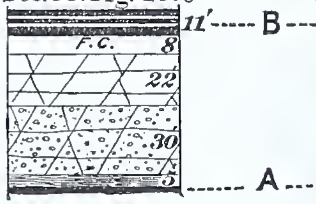
Sec.34. Fig.45. §301



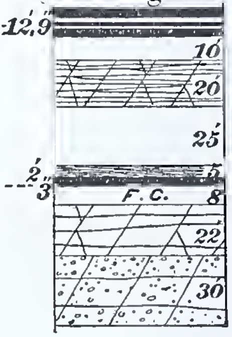
§308.
Sec.37. Fig.48*a*.



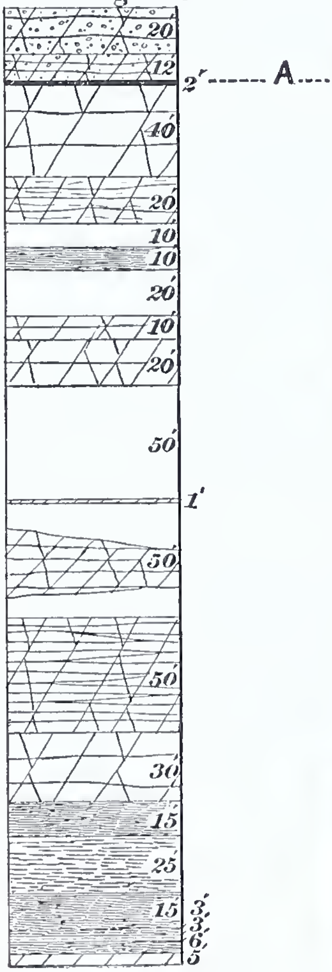
Sec.35. Fig.46. §303.



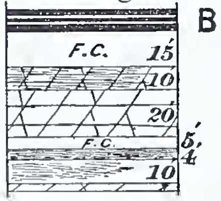
§308 Sec.37. Fig.48 *b*.



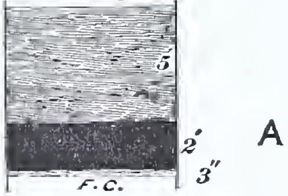
Sec.33. Fig.44. §295.



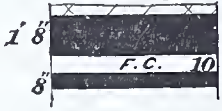
Sec.39. Fig.50. §312.



§304.
Sec.36. Fig.47.



§311.
Sec.38. Fig.49.



CHAPTER II.

The Bernice Coal Basin.

§ 290. *Situation.*—The Bernice Coal basin lies within the limits of Birch creek on the north and Loyalsock creek on the south; between the junction of Birch creek and Loyalsock creek on the west and a point a little east of Pigeon creek on the east.

§ 291. *Area.*—The actual *producing coal area* is very much less than these limits: the Big Bed or coal bed B covering only a small part thereof: but it is properly called the coal basin wherever the Pottsville conglomerate of XII and the small A bed of coal may exist, even though the only valuable deposit, bed B, may be eroded.

The outer limits of the basin are sufficiently clearly defined, though the heavily wooded hill-sides make it difficult to locate exactly on the maps the exposures and sections without instrumental work. It is indeed all thick woods and brush in the coal basin except the small clearing for the village of Bernice.

§ 292. *Shape.*—The basin itself is a canoe-shaped synclinal, rising out both at its eastern and western end, flattening more and more as it rises, until the Pottsville conglomerate alone remains capping the highest hill tops. While the length of the basin is in all some 6 miles from east to west, the synclinal is so narrow that at the Bernice mines it is scarcely 600 yards across from outcrop to outcrop on the Coal Bed B.

§ 293. *The vertical sections* as obtained in the Bernice Coal basin are neither complete nor satisfactory: and their disagreements, which are considerable, are further complicated by some records of bore holes put down some 10 years ago.

§ 294. *Bore hole records* as roughly kept by the men doing the borings, are always sufficiently unreliable: and after all this time has elapsed, so as to render personal memory useless, it is scarcely worth while to attach importance to this mass of unauthenticated evidence which disagrees as flatly with itself as it does with what is known from other and better sources.

§ 295. *Loyalsock section.*—At the western end of the basin, where the most western coal opening has been made, and where the basin is pointing up to the westward so rapidly as to preclude any further extension of the Lower Productive coal measures in that direction, the following section was made from the coal opening down to the Loyalsock creek. The location of the section is at a point on the Loyalsock creek fully two miles above where Birch creek comes into it, and some three miles below the Schreyfogel hotel.

Loyalsock Section, west of Bernice. Sec. 33, Fig. 34.

Hill top.	*Feet.*
Interval, apparently conglomerate sandstone,	20
Sandstone, conglomerate,	12′ to 15
Coal, A (?), fallen shut,	2
Sandstone, only imperfectly exposed, apparently massive,	40
Sandstone, gray,	20
Interval, not seen, apparently sandstone,	10
Brown and reddish slates,	10
Interval rocks, not seen,	20
Drab colored sandstone,	10
Gray sandstone,	20
Interval rocks, not seen,	50
Red sandstone,	1
Gray sandstone, partially seen,	50
Gray sandstone, thin bedded,	50
Massive grayish sandstone,	30
Gray and yellow slates,	15
Red slates,	25
Dark colored slates,	15
Massive bluish gray sandy slate,	3
Soft easily decomposed gray slate,	3
Massive blue gray sandstone, with a curious layer in it of *red conglomerate*, not quartz pebbles but small lumps of slate and sandstone held together by a matrix of reddish sandstone, with numerous *fossil plants*, showing in all a thickness of,	6
Red sandstone, to creek level,	5
Total,	419

§ 296. *XII.*—The Loyalsock creek bed is at this place covered over with large *bowlders of* XII which have come down from the hill tops at the upper part of the above section.

It is very noteworthy in this section that brown and reddish slates 10 feet thick, come in only 70 feet below the A coal bed: and below these red slates and some concealed rocks (for 20 feet) there are measures which strongly resemble the Pocono group. The rocks are grayish and greenish and much currentbedded, rarely massive. The section therefore indicates that the *Pottsville conglomerate* (XII) on the north side of the western end of the Bernice Coal Basin is *only 70 feet thick.*

§ 297. *A so-called iron ore* which was found on this slope of the north bank of the Loyalsock creek, but the precise horizon of which could not be found, was analysed by Mr. McCreath and found to yield only 6.30 per cent. of metallic iron, with 70.51 per cent. of insoluble residue. It is merely a worthless red shale. But it has given rise to many assertions that iron ore was plentiful along the Loyalsock. The fact is, that many beds of red shale, both in XI and in IX, contain from 5 to 10 per cent. of iron; but that does not make them a practical iron ore.

§ 298. *Coal A* was opened some few feet below the hilltop (about 15 feet;) and the hilltop is massive sandstone with conglomerate layers.

It has been looked upon as the upper bench of bed B; but it seems much more likely that it is the small coal bed underlying bed B by from 35 to 60 feet. The overlying and underlying rocks all point to this identification.

The size of the bed cannot now be measured. Mr. Woodward reports it as about "2 feet of coal;" with a *slate roof.*

No examination of bed A in place could be made at this old western opening, nor could any specimen be procured for analysis.

§ 299. *The massive conglomerate rock over A* in the section, makes a broad flat hilltop and can be followed eastward until the plainly defined bench of coal bed B is struck.

§ 300. *Coal B.*—Its outcrop line is west of the western line of the State Line and Sullivan Railroad Company, but not far west of it; and there is but a small acreage of bed B west of that company. The exact acreage could easily be run out; but such specific detail is of small interest to any one except the owner of the tract and has but little bearing upon the general value of the basin.

Old Jackson mines; and mines of the Sullivan and Erie Railroad and Coal Company.

§ 301. *Old Jackson mine on big bed B.*—Going eastward along the center of the Bernice basin, near the western boundary line of the lands of the State Line and Sullivan Railroad Company we come to what is known locally as the "Old Jackson mine," half a mile west of the present mines of the State Line and Sullivan Railroad Company.

Here on the Jackson property, the big bed of coal was opened many years ago showing 8′ 1″ of coal in 11′ 1″ of room between floor and roof; thus, Sec. 34, fig. 45.

	Sandstone, micaceous, current-bedded, thin bedded, fine grained, gray colored,	5′ +	
B.	*Coal*, upper bench, averages,	3′	0″
	Slate parting,	1′	0″
	Coal,	1′	3″
	Slate, with some coal intermixed,	2′	0″
	Coal,	3′	10″

This gives 8′ 1″ of *coal* in 11′ 1″ of measures between roof and floor.

The coal is not worked at present. Judging from appearances, without analysis, it would seem to be of the same character as the coal worked from the company's mines, just east of Jackson's.

§ 302. *Measures over B.*—Overlying the coal bed B at the Jackson mine there is nothing showing except thin bedded sandstone; and this rock of the same general character makes up the whole covering, to the hilltop, some 80 or 90 feet above the bed.

§ 303. *Under B* on the Jackson tract are seen the following rocks in place Sec. 35, fig. 46.

Coal B, as above,		11′
Fireclay,	interval, 60′	8′
Massive hard sandstone,		22′
Conglomerate massive,		30′
Black slate, (roof of A,)		5′

The measures between coal beds A and B are massive sandstone and conglomerate, making a steep cliff, and fully as well marked on the topography and as massive as the conglomerate under A.

§ 304. *Jackson opening on Coal A.*—On the same hill side as the "Jackson mine," on bed B, the lower coal bed, or A, has been opened for examination on the outcrop.

It lies at this place, 65 feet below bed B, and measured thus: Sec.36 , fig. 46.

A	Black slate (roof),	5′ +	
	Coal,	1′	11″
	Slate,	0′	3″
	Fireclay, hard, (floor),	——	

§ 305. *Coal A elsewhere.*—The same bed has been opened at various other places in this same vicinity, and always yields about the same average of 22 to 24 inches of coal.

§ 306. *The character of coal A* is very curious. A specimen yielded, on analysis, (A. S. McCreath):

"Water,	4.130
Volatile matter,	15.270
Fixed carbon,	67.362
Sulphur,	.523
Ash,	12.715
	100.000
Color of ash,	reddish gray.

The coal does not yield a coke, and the gases burn with a *very feebly* luminous flame.

The coal after being dried begins to absorb water rapidly and in two hours has re-absorbed about 60 per cent. of the water originally present. This amount is not increased by longer exposure."

On drying at 225° F. the coal loses	4.13%
At 245° the loss is the same.	
At 260° the loss is	4.19%
At 340° the loss is	4.50%
At 460° the loss is	4.69%
At a dull red heat the loss is	12.59%

But in all these experiments the water re-absorbed is about the same; that is, the coal re-absorbs about 2.48 parts of water.

Irrespective, therefore, of the amount of water, &c., driven off by heat, the portion re-absorbed is practically constant, and this property is not destroyed even after all the volatile matter has been driven off.''

§ 307. *Mine No. 5, on Coal B.*—Eastward of the old Jackson mine is Mine No. 5 of the State Line and Sullivan Railroad and Coal Company. It is an old mine, not now worked, but the bed in the drift was of full size and good character.

The parting between the top coal and middle coal is here 3 feet thick.

Level of the floor above tide, 1829 feet. The roof rock and all above it are sandstones; where the surface of the ground rises highest about 80 feet of sandstone strata cover the coal.

§ 308. *Section at Mine No. 5.*—Sec. 37, Fig. 48.—An imperfect section of the measures at Mine No. 5 shows thus:

Sandstone to hill top,		up to say	80′ 0″
Coal B,	Coal,	3′ 0″	12′ 9″
	Slate,	3′ 0″	
	Coal,	1′ 3″	
	Slate and coal,	1′ 6″	
	Coal,	4′ 0″	
Interval rock, not seen,			10′ 0″
Sandstone, thin-bedded,			20′ 0″
Interval rocks, not seen,			25′ 0″
Black slate,			5′ 0″
Coal A,			1′ 11″
Slate,			0′ 3″
Fireclay,		7′ to	8′ 0″
Hard sandstone,			22′ 0″
Conglomerate sandstone,			30′ 0″
Wash and drift,			——
Total,			214′ 8″

§ 309. *Coal A.*—The lower coal, though only opened on the outcrop, is good, bright, and hard. The thickness above given, 23 inches, is about the average of the different openings made on this bed.

§ 310. *Mine No. 4, on Coal B.*—East of Mine No. 5 is Mine No. 4 of the railroad and coal company; in which coal B is worked.

Level at mouth of drift, 1810′.

The parting between the top coal and middle coal is 3′ thick; and the coal itself is of the usual size and character.

§ 311. *Coal A.*—Forty-five feet below the floor of coal bed B is an opening on outcrop of a coal bed which shows: Sec. 38, fig. 49.

	Sandstone roof.	—
A	Coal,	1′ 8″
	Fireclay,	0′ 10″
	Coal,	0′ 8″

This is the lower bed, of its usual size, and with 15′ less interval rock between it and coal B.

§ 312. *Borehole trial to find A.*—But in Mine No. 4, 300 yards in from the outcrop, the coal having raised in that distance 11 feet, and keeping perfectly regular and undisturbed, a borehole was put down in order to test the lower coal bed, which showed so well on outcrop. The measures passed through are shown in Sec. 39, fig. 50.

Fireclay, (floor of coal B,)	15′ 0″
Drab rock, very hard,	10′ 0″
Hard sandstone,	20′ 0″
Fireclay,	5′ 0″
Slate,	4′ 0″
Dark slate and clay, (place of coal B,)	10′ 0″
Sandstone, (boring left off in sandstone.)	—
Total,	64′ 0″

There were not 6 inches of coal in all in the dark slate and clay which occupy the horizon of the lower coal bed. It may be that the borehole has passed through only a washout of the lower coal, which would prove small and have the bed on all sides in good order; but there is so much irregularity in these measures in the Bernice basin as to prevent any great hopefulness for improvement or persistency.

§ 313. *Cut-out of bed B.*—Between Mines No. 4 and No. 3, the coal was entirely cut out over a moderate area; the mining showed only mud, dirt, and loose trash.

§ 314. *Mine No. 3 on B.*—Eastward of Mine No. 4 is Mine No. 3, or the Breaker Mine. At this mine is the breaker, with a capacity of 500 tons daily.

The coal is of the same size and character as already described, and the parting between the top coal and middle coal is only from 3′ to 4′ thick.

Level of drift, 1804′ above tide.

Level of coal A, 1734′ feet above tide. Difference, 70′.

The lower bench has not been opened at the breaker, and no section of the interval rocks can be seen there.

§ 315. *Mine No. 2, on coal B.*—Eastward of the Breaker Mine is the Company's Mine No. 2, in which the coal of bed B remains about the same as before, but the parting between the top coal and the middle bench has grown to be 7′ or 8′ thick.

Level of drift floor, 1800′ above tide.

The lower bench has not been touched at all at this place.

§ 316. *Mine No. 1, on B*, is east of Mine No. 2, and *here the interval between the top and middle* benches has grown to 30′.

The middle and lower benches keep together as before; and these alone are worked. All three, upper, middle, and lower, keep their usual size, and show no change in appearance.

Level of drift mouth floor, 1793.5′ above tide.

§ 317. *Production from bed B.*—The State Line and Sullivan Railroad Company have an extensive plant at Bernice. They have five drifts on coal bed B, besides breaker, sidings, houses, store, &c.: and are shipping from 40,000 to 50,000 tons of coal yearly; all of it from bed B.

§ 318. *Average thickness of Coal B.*—A fair average of several measurements of bed B as made in the different drifts is as follows:

Roof, sandstone, thin bedded, micaceous.

Bed B.	Coal,	3′ 0″
	Slate parting,	3′ 0″
	Coal,	1′ 3″
	Slate, with coal intermixed,	9″ to 1′ 6″
	Coal.	4′ 0″

Or about 8 feet of coal in all. It is generally quite free from slate either as thin layers or in lenticular masses.

§ 319. *Analyses of Coal B.*—Specimens of the three benches of coal in bed B, as mined at Bernice, were forwarded to the Laboratory of the Survey for analysis. They yielded as follows (A. S. McCreath):

Taking the general average of all the benches together, as they are shipped to market:

"The coal is bright, shining compact, and shows considerable charcoal and iron pyrites.

Water,	1.295
Volatile matter,	8.100
Fixed carbon,	83.344
Sulphur,	1.031
Ash,	6.230
	100.000
Color of ash,	grey.

Of course it makes no coke: but is a *true anthracite:* and the above analysis represents fairly the character of the coal as furnished in quantities from the Bernice mines.

On analysing separately the coal from the three benches the result was as follows:—

"The coal is generally very firm and compact; it has a deep black shining lustre and is seamed with bright crystalline coal. It carries considerable mineral charcoal in thin partings, and shows only a small amount of iron pyrites, existing generally in thin scales. The coal from the top bench has a seam of greyish black cannel like coal running through it: but the other specimens seem almost free from this. The coal does not coke, and yields gases which burn with a very feebly luminous flame.

The top bench of coal yields:

Water,	1.840
Volatile matter,	9.835
Fixed carbon,	76.788
Sulphur,	.647
Ash,	10.890
	100.000
Color of ash,	cream.

This coal is nearly the same as the coal yielded by the middle and lower benches, but is not quite equal to them in quality, as it carries more ash.

The middle bench yields:

Water,	1.800
Volatile matter,	9.650
Fixed carbon,	82.373
Sulphur,	.622
Ash,	5.555
	100.000
Color of ash,	grey.

This is the purest coal of the mine.

The lower bench yields:

Water,	2.200
Volatile matter,	9.405
Fixed carbon,	81.267
Sulphur,	.618
Ash,	6.490
	100.000
Color of ash,	cream.

This coal is up to or beyond the average character of the whole bed; and it is noteworthy that it carries a little more water than either of the upper benches.

§ 320. *Cannel slate layer.*—Mr. McCreath made an analysis of the greyish-black cannel-like coal layer, running through the top bench of coal. It should more properly be called the cannel slate layer, though the expression cannel slate scarcely applies to one containing so small a proportion of volatile matter.

The greyish-black cannel-like coal yields:

Water,	1.950
Volatile matter,	9.030
Fixed carbon,	63.795
Sulphur,	.583
Ash,	24.640
	100.000
Color of ash,	cream.

§ 321. Taking the *average of the analyses* of the coals from the three benches, it will compare with the analysis of the average run of the mine thus:

	Av. of the benches.	*Av. run of mine.*
Water,	1.953	1.295
Volatile matters,	9.630	8.100
Fixed carbon,	80.143	83.344

Sulphur,	.629	1.031
Ash,	7.645	6.230
	100.000	100.000

It is curious to marked is the difference in the per centages of water and of volatile matters. Variations and errors may be looked for in analyses of specimens from coal mines however careful may have been the selection of the specimens. It should be mentioned here however that the *average* sample was selected in *1876* while the three samples from the different benches were taken in *1878;* and the character of the coal may have changed as the mine was worked forward. The analyses taken together however establish clearly enough the general character of the coal. And it is a very remarkable one.

§ 322. *Bernice Anthracite.*—For, by any system of classification the coal is an anthracite. Leaving out the accidental impurities, and counting only the ignitible constituents of the fuel, we have:

Fixed carbon,	91.142
Volatile matter,	8.858
Proportion of vol. matter to fixed carbon,	1:10.289

But while the Bernice coal from bed B is thus clearly an anthracite, and is used for exactly the same purposes and in the same way as the other Pennsylvania anthracite coals, yet in its appearance and structure it differs much from them.

It has a dull lustre, instead of the well-known shining lustre of the other anthracites, and it entirely lacks the conchoidal fracture which is possessed by every other Pennsylvania anthracite.

So different is it in physical structure that it cannot be passed through an ordinary anthracite breaker. Such a breaker would so crush it as to leave little beside slack and pea coal.

§ 323. *Bernice breaker.*—But in the breaker at Bernice a massive plate, fitted with iron teeth, takes the place of the crushers. This plate, in descending, strikes the coal lumps, and taking advantage of the tendency of the coal towards a partial cubical structure, easily splits the lumps into pieces of varying size, and practically turns out about the same proportion of the various sizes of coal (and with no more wastage) as the average at collieries in the anthracite regions.

A more complete discussion of the character of this coal, as well as the other coals of Sullivan county, will be found in the chapter devoted to that subject and to comparing them with other coals to the north and south of them.

§ 324. *Market.*—The Bernice mines ship some 40,000 or 50,000 tons annually to market, none of the coal going southward, of course; all of it being shipped northward into New York State.

§ 325. *Divergence of the benches.*—Between Mines No. 2 and No. 1, the *lower benches* of the coal bed B have sunk to the eastward 65′; and on driving off to the eastward in the mine, these lower benches were found to continue steadily sinking to the eastward. This drifting continued for 300 feet, but as they were going to the dip the water proved very troublesome, and working was suspended. A drift is now being put in from a lower level to drain these workings.

In the meantime the *upper bench* seems to have been continuously *rising to the eastward* after leaving Mine No. 2.

§ 326. *School-house bore hole.*—A bore-hole was put down near the school-house, 1000′ east of mine No. 1; and its record is as follows Sec. 40, fig. 51.

Surface, 1866′ above tide.

1.	Sandstone,		30′ 0″
2.	*Coal,*		3′ 0″
3.	Slate,	Parting of 45′	11′ 0″
4.	Fireclay,		20′ 0″
5.	Slate,		4′ 0″
6.	Fireclay,		10′ 0″
7.	*Coal,*		1′ 3″
8.	Slate,	Parting of 11′	2′ 0″
9.	Fireclay,		9′ 0″
10.	*Coal,*		5′ 0″
	Total,		95′ 3″

The three coals of the above section (Nos. 2, 7 and 10) have been supposed to be the three benches of the Big bed B, separated by unusually large partings.

There is a coal outcrop on the road side, just about at the level of the top bore hole, which may be the upper bench of B. If the interval distance between the top coal and middle coal increased from 7 or 8 to 30 feet in the short distance between mines No. 2 and No. 1, there is nothing impossible or even improbable in the continuance of that rate of rise for the 1000′ further east to the bore hole: and this rate of rise would easily bring the top coal up to or even above the top of the bore hole.

§ 327. *Saw-mill bore hole.*—Another bore hole was put down, north of the previous one, towards the saw-mill. It started at 1816′ above tide or 50 feet below the first one. The record shows: Sec. 41, fig. 52.

1.	Surface earth,		22′ 6″
2.	Slate,		8′ 6″
3.	Fireclay,		7′ 0″
4.	Gray sandstone,		12 0″
5.	*Coal,*		0′ 6″
6.	Slate and fireclay,		26′ 6″
7.	*Coal,*		1′ 6″
8.	Fireclay and slate,		7′ 6″
9.	Brown sandstone,		25′ 0″
10.	Slate and sandstone, mixed with *Coal,*	7″	1′ 8″
11.	Dark sandstone, mixed with *Coal,*	10″	
12.	*Coal,*	3″	
13.	Sandstone,		2′ 6″

Mine No. 1, on the two lower benches is at *1793.5′ above tide* and sinking to the eastward: the coal at the bottom of the school-house bore hole (5 feet of coal) is at *1772′ above tide:* and it seemed natural to conclude that this large coal represented the bottom bench of coal B.

But coal No. 5 of the saw-mill boring which occupies the horizon (*1776′ above tide* and a only short distance away) is only 6 inches thick: and there is no coal in the saw mill boring of even one third of any such thickness as five feet.

§ 328. *The new drift* for drainage is now going in, starting near the saw-mill, at *1767′ of tide*, and is striking for the 5′ coal at 1772′ at the bottom of the school-house boring. By connecting it with the mine workings it will drain out everything.

§ 329. *The coal outcrop* which shows in the road east of the White House, and shows also near the school-house bore hole, sweeps around east and crosses the Susquehanna and Bernice turnpike in a plainly defined bench. Here it has little cover, and was once picked into and some coal and slate thrown out from it. But it points out to daylight directly east of the turnpike in a narrow nose and the ground falls away all around it making a swamp and lowland over a considerable area.

East of Bernice.

§ 330. A careful examination of the hill side sloping to *Birch creek at Bernice*, and of the hill sloping to the Loyalsock creek south of Bernice failed to give any complete and satisfactory sections.

§ 331. *Shinersville conglomerate.*—One mile north of Bernice, and therefore on the north side of Birch creek, near the Shinersville school-house, there is a cliff outcrop of conglomerate 25 feet high; and north of it smooth plain with reddish soil.

Massive gray sandstone, in the cliff, dips 8° south, 15° east. Few of the layers are less than one foot thick; and there are occasional layers of pebble rock. These pebbles are chiefly of white quartz, not much rounded, mostly of considerable size, from that of a large pea to a filbert. In this they differ from the pebbles in the conglomerate between coal beds B and A, which are rounded and small. If this *Shinersville conglomerate* were the same as that between beds B and A, coal bed B would be caught on the north side of Birch creek; of which fact there is certainly no evidence.

The 8° (S. 15° E.) dip, if continued with the same force to and under Birch creek, would carry down the *Shinersville conglomerate* (here 1950′ above tide; Birch creek being 1710′; and the coal 1800′) 600 feet beneath coal A. But as this is an impossibly large interval, it is evident that the dip flattens quickly, and that the *Shinersville conglomerate* is not over 200 feet, if so much, below coal bed A.

§ 332. Following the face of the high *Shinersville hill* westward to a point two miles west of Shinersville, and opposite (and north of) the west end of the Bernice basin, we see the high hill top (2000′ above tide) capped by a massive sandstone, gray colored, and with some conglomerate layers of white quartz pebbles. This is probably the same rock exposed at Shinersville. The Birch creek crossing (about one mile down the creek) is 450′ lower in level than this hill crest; and the whole interval of 450′, somewhat imperfectly exhibited, seems filled by current-bedded, greenish gray sandstones, mostly thin-bedded and evidently including some red layers, although not many of them. These softer red layers are usually covered over with loose stuff, and do not show their thickness. The thickness of such soft red layers is usually over-estimated, because they disintegrate easily, slide down and make a great show of outcrop.

§ 332. The Shinersville section, when compiled, may be thus stated:

1. Coal bed A,	—
2. Pottsville conglomerate, as much as	190′
3. Mauch Chunk red shale, perhaps not more than	25′
4. Pocono sandstone to bottom of section,	450′
	665′

§ 333. The vertical section compiled on the north and south banks of the Loyalsock, *south of Bernice*, corresponds somewhat closely with the above.

§ 334. The hill slope on the *north side* of the Loyalsock along the turnpike has much loose stuff scattered over it and shows few exposures of rock in place.

It is apparent, however, that the *Pottsville conglomerate* is not more than 200 feet, if so thick. The Loyalsock creek cuts deep and is only about 1550 feet above tide where the turnpike crosses it.

§ 335. On the *south side* of the Loyalsock creek, rocks show frequently in place, dipping north, towards and under Bernice, and are the current-bedded, greenish gray sandstones of the *Pocono* group. Several hundred feet of them are exposed.

§ 336. *Schreyfogel's limestone.*—On the hillside, south of Schreyfogel's hotel, and 170 feet above the level of the Loyalsock creek, was opened a quarry of greenish siliceous limestone, poor and sandy, and not fit to burn for lime. The bed is seamingly thin; and it must lie three hundred feet, more or less, beneath the Pottsville Conglomerate.

A greenish sandy limestone, perhaps the same, is found on the hillside on the south side of Birch creek, *5 miles east of Schreyfogel's*, near Hopkin's house. It lies fifty feet above the red rocks which come in and extend down to the creek at that place.

§ 337. On the 2,075′ crest, two miles west of Schreyfogel's hotel, on the south side of the Loyalsock, along the plank road, lie massive bowlders, seemingly of the Pottsville Conglomerate, which occurs near the highest part of the hill; and if any coal measures are caught in the hilltop south of the Loyalsock they must be in this crest; but they can cover but a small area. The country is a rugged wilderness and shows no outcrop; and no effort has been made to develop any coal horizon.

§ 338. *Pigeon creek* heads up three and a half or four miles east of the Susquehanna and Bernice turnpike, on the northern side of the coal basin, and flows southward into the Loyalsock.

Bed B, the large coal bed, has been opened here, on Pigeon creek; the following vertical section, (barometric measurement,) has been furnished by Col. Ricketts, of Wilkes-Barre:

Coal B,	—
Massive conglomerate,	55′
Coal A,	—
Sandstone, thin bedded, fine grained,	200′
Red shale,	—

This is nearly at the eastern end of the Bernice coal basin.

§ 339. The old "*Pigeon creek opening*" on bed B, four miles east of Bernice is not worked, but the coal appears to be about the same in size and character, as at Bernice.

Mr. McCreath thus describes a specimen forwarded to him for analysis:

"The coal has a dull lustre generally, being for the most part coated with a thin film of silt; on fresh fracture the lustre is black and shining. The specimens seem in the main free from iron pyrites.

Water,	2.340
Volatile matter,	8.440
Fixed carbon,	80.949
Sulphur,	.726
Ash,	7.545
	100.000
Color of ash,	cream."

It is evident that the coal in this Pigeon creek area of bed B (however much that may be) will resemble in all respects the coal now shipped from Bernice.

§ 340. *Coal openings east of the turnpike.*—The railroad company have explored a coal outcrop, less than one half a mile east of the turnpike, and 1826′ above tide. Sec. 42, fig. 53.

Sandy slate,		2′ 0″
Dark slate,		1′ 0″
Coal,		2′ 0″
Fireclay floor,		1′ 3″
Blue slate,	in Borehole,	3′ 0″
Fireclay,		6′ 0″
Blue slate,		5′ 0″
Sandstone,		—

§ 341. Another outcrop, half a mile east of the turnpike, and only 1783′ above tide, (43′ below the above,) showed at the outcrop: Sec. 43, fig. 54.

Sandstone, massive, gray,			15′ 0″
Slate,			0′ 6″
Coal bed.	*Coal,*	0′ 5″	5′ 4″
	Slate,	0′ 4″	
	Coal,	0′ 5″	
	Slate,	0′ 6″	
	Coal,	1′ 0″	
	Bone coal,	0′ 3″	
	Coal,	2′ 5″	
Sandstone in bottom.			

Mr. McCreath's description of a sample from this opening is as follows:

"Coal of a deep black color; rather friable; much coated with infiltrated silt; partings of slate, numerous.

The coal yields gases which burn with a non-luminous flame; but it does not have the slightest tendency to form a coherent coke.

The dried coal re-absorbs water with great rapidity.

Water, @ 225°,	4.810
Volatile matter,	14.085
Fixed carbon,	64.436
Sulphur,	.549
Ash,	16.120
	100.000

Color of ash, reddish gray.

Fuel ratio, ... 1:4.57"

§ 342. The *Donovan mine* is a trial opening made by the Coal Company, one and a half miles east of Bernice, at 1847′ above tide, (coal B at the breaker at Bernice being 1804.) Sec. 44, fig. 55.

Sandstone, massive, gray,			30′ 0″
Coal bed.	*Coal,*	1′ 3″	10′ 11″
	Slate and fireclay,	6′ 0″	
	Coal,	3′ 8″	
Fireclay floor.			

Mr. Woodward drifted in on the coal sufficiently to reach firm coal for measurement and to secure specimens for analysis by Mr. McCreath, who made the following report of specimens from the benches analysed separately:

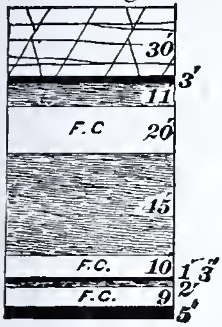
1. *Top bench.*—"The coal has a dull, dead lustre; it is very soft and crumbling, and has a somewhat shaly appearance, with laminated structure. The gases burn with a feebly luminous flame, but the coal does not yield a coke.

Water,	7.930
Volatile matter,	21.410
Fixed carbon,	54.099
Sulphur,	.551
Ash,	16.010
	100.000

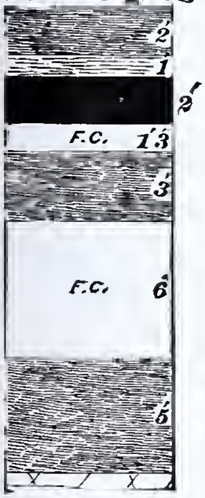
Color of ash, ... cream.

2. *Bottom bench.*—"The coal is deep black, hard and brittle.

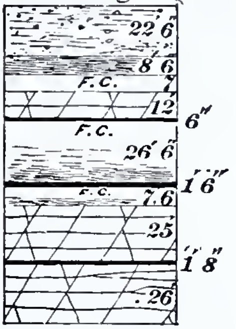
Sec. 40. Fig. 51. §326



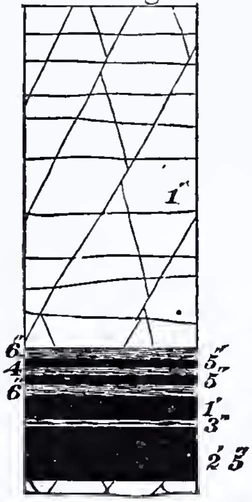
Sec 42. Fig 53. §340



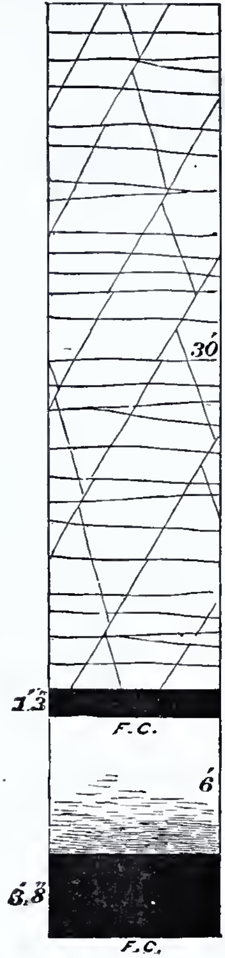
Sec. 41. Fig. 52. §327



Sec. 43. Fig. 54. §341



§342 Sec 44. Fig. 55.



Water,	2.910
Volatile matter,	11.780
Fixed carbon,	81.672
Sulphur,	.598
Ash,	3.040
	100.000
Color of ash,	cream."

§ 343. The analyses of coals of this basin already described, have shown some curious features, but none so embarrassing as the two analyses given above.

In the first place *the percentage of water* in the coal from the top bench is unusually large, nearly three times as great as the percentage of water in the bench below, separated from it by only 6 feet of slate and fireclay.

The carbon ratio.—Throwing out the accidental impurities and counting only the ignitible constituents, we have for the top bench:

Fixed carbon,	71.646	1 : 2.527
Volatile matter,	28.354	
	100.000	

but for the bottom bench:

Fixed carbon,	87.394	1 : 6.932
Volatile matter,	12.606	
	100.000	

that is, according to the usual classification of coals, *the upper bench is a bituminous coal, and the lower bench an anthracite.*

Dismissing the subject for the present, it is hardly necessary to remark that these analyses afford no clue to the identification of this bed with the large bed B or with the underlying bed A.

§ 344. From another opening in the top bench of this curious coal bed, specimens were taken for analysis on which Mr. McCreath reports thus:

"It was very wet when taken out of the box. The first analysis represents it in this condition. On exposure to the air of the Laboratory for 16 hours it loses 8 per cent. of water; and this amount is not materially changed after

30 hours exposure. The second analysis represents the coal after it had been air dried for 16 hours.

"The coal is for the most part in fine powder. It has a dull dead lustre with somewhat shaly appearance. It is very soft and crumbling and has the same general character as the coal from the top bench (previously analysed,) see MM, page 94, analysis No. 938. The gases burn with a non-luminous flame, but the coal does not coke at all. As usual, it re-absorbs water very rapidly, just like the other Bernice coal.

"The analyses are as follows:

	Wet Coal.	Air-dried Coal.
Water, @ 225,	15.060	7.060
Volatile matter,	22.680	24.816
Fixed carbon,	50.993	55.796
Sulphur,	.372	.407
Ash,	10.895	11.921
	100.000	100.000
Color of ash,	reddish gray.	
Fuel ratio,	1:2.24	

§ 345. The *shape of the basin* at Bernice has been made out very plainly by the gangways and trial shafts.

Its width from crop to crop, west of the Susquehanna and Bernice turnpike is not over 600 yards; and the southern outcrop is from 30′ to 35′ higher than the northern.

Entering by the northern outcrop the coal bed sinks gently south as much as 8 feet; then rises gently to the southern outcrop; the mine draining easily.—Going westward along the basin, the coal bed gently rises all the way from Mine No. 1 to Mine No. 5.—The curious irregularities between Mine No. 1 and the turnpike (to the east of it) have been already stated.

Its length, from the Susquehanna and Berwick turnpike to the westernmost proved point of the Big bed is about 2400 yards; the width, as above stated, not exceed 600 yards.

§ 346. *Difficult identification east of the turnpike.*—It will be observed that no letters (A, B,) have been given to the coal bed opened east of the turnpike, except on Pigeon creek; where the coal bed is clearly coal B.

A brief recapitulation of the principle facts will suffice to explain the difficulties attending any identifications east of the turnpike.

Starting then from the western end, the old Jackson mine, and proceeding eastwards :—

At the Jackson opening the bed B is in three benches,—8 feet of coal in 11 feet of measures,—roof and floor regular and even,—the bed making a plain broad bench along the hill side.

This state of things continues for more than half a mile, the western openings of the railroad company having the coal bed in exactly the same condition as at the Jackson mine.

But in driving their headings to the eastward, from their easternmost opening, the interval between the upper and middle benches steadily increases, the upper bench rising and the middle and lower benches together sinking eastward. At the same time the well marked terrace along the surface of the hill slope disappears.

For three miles east of the Bernice mines, bore hole records and outcrop openings show only single coal beds; usually small; very variable; differing in character from each other and from the coal mined at Bernice. If the bore hole records be accurate there are places where no coal at all exists.

On Pigeon creek, however, three and a half miles east of Bernice, there is an old opening, in which coal B exhibits the same size, number of benches, partings and general character that it does in the Bernice mines; but the locality is very limited, for a bore hole, not far west, found no coal at all. At the Pigeon creek opening, also, the terrace on the hill-side is as well defined as at Bernice.

There are plenty of instances of single coal beds splitting into two or more by the thickening of thin parting slates; but here the benches of a coal bed part company for such a distance and so rapidly as to destroy its value altogether, and then come together as rapidly as they parted and reconstitute the bed of its original size and value.

Under such circumstances it is impossible to identify the trial openings with any certainty, or to assign a specific value to that part of the Bernice basin which lies between the Susquehanna and Berwick turnpike and the Pigeon creek coal opening.

§ 347. *Cross section*, Fig. 56, has been drawn to exhibit the general structure of the Bernice coal basin, and the thickness of the coal measures, and of the rocks immediately underlying them.

The section line crosses the Loyalsock where it is 1575 feet above ocean level. The Bernice hill top is about 1875 feet; the Bernice coal mines 1800 feet; Birch creek, a little over 1700 feet; and the hill top at Shinersville about 1950 feet.

North of Birch Creek.

§ 348. *Shinersville conglomerate.*—Starting from the north or Shinersville side the first conspicuous exposure is near the Shinersville school-house,—conglomerate rocks, dipping to the south 20° east, 5° to 8°, (but no doubt soon flattening)—thickness exposed, 30 to 40 feet,—a very massive sandstone—mostly gray, occasionally bluish and spotted, and with numerous layers of white quartz pebbles. These layers, only a few inches thick, not at all current-bedded, lie parallel to each other and as regularly stratified as the other strata. With these exceptions, the exposure is one of massive sandstone layers without pebbles.

§ 349. *Red rocks of XI.*—On the flat, north of Shinersville, the exposures of rock in place are very imperfect. A *red rock*, softer and more easily disintegrated than those above and below it, seems to come in just under the *Shinersville conglomerate* and makes a smooth flat, which offers no exposures. This red rock cannot be thick, (perhaps not more than 25 feet,) for, on going northward only 400 yards north of Shinersville, a fine-grained, current bedded, generally thin bedded, though sometimes massive sandstone, (Pocono, No. X,) becomes the country rock; dipping to the south 20° east, about 5°±; making a ridge back of (north of) Shinersville; red rocks coming in to the north of the ridge and passing underneath it. This *lower red rock* is probably the top of the Catskill formation, No. IX.

A very gentle and even slope extends from the Shinersville school-house southward to Birch creek; covered deep with loose stuff and offering poor opportunities for observing the rocks in place.

§ 350. *Conglomerate rock* in place is exposed on the north side of Birch creek, just opposite to the breaker. It is at least 400 to 500 yards distant from and 125 feet above the creek, that is, not much lower than bed B on the south side of the creek.

The dip here must therefore be to the southward, for this conglomerate must sink 100 feet, more or less, between this point and the Breaker mine.

Most of the rock layers of this exposure are of fine-grained sandstone, with some conglomerate alternations.

It is not so much a mixed conglomerate mass as the rock showing in the railroad cut, near the saw mill, at Bernice; though, as the latter is lower, and in the line of the dip, they are probably part of one great conglomerate horizon.

The rocks where exposed near Birch creek are nearly horizontal, and the steep dip of Shinersville has entirely ceased to exist long before the rocks reach Birch creek.

§ 351. *Pocono strata.*—Two thirds of a mile down Birch creek, and one half of a mile north of Birch creek, massive greenish-gray sandstones, several feet thick, show in place. These are nearly 200 feet above Birch creek, but they are so far to the north that the 5° dip would naturally carry them entirely underneath XII.

One fourth of a mile further down the creek this greenish-gray sandstone is again found, with a small quantity of fine white pebbles imbedded in it.

§ 352. *Junction of XII and XI.*—At A. Prendergrast's place, 2 miles by railroad from Bernice, there is an exposure of considerable interest.

The opening is 300 yards north of the railroad track, and about 135 feet above Birch creek at Bernice.

The top rock is made up of fine-grained sandstone, with layers of very small (pin head) white pebbles. This sand stone is 45 feet thick in all, and massive.

Directly under it comes a rich red colored aluminous rock, called an "iron ore," and 8 feet thick.

It weathers quickly on exposures into a crumbly mass.

Under the "ore" is a dark red clay, and nothing below that is exposed.

The ore is of course entirely worthless as an *iron ore*, holding probably less than 10 per cent. of metallic iron.

But the exposure is of interest as showing the contact of the bottom of XII, with the top of XI; and it is easy to see how even a moderate thickness of this crumbly red rock would spread over an extensive area, and much exaggerate its own apparent thickness.

It does so at this place; at Shinersville where it makes deep red the whole region north of the conglomerate ledge, and indeed has sent much red stuff all the way down to Birch creek; and it makes a bright line along the crest of the Allegheny mountain, 15 miles to the south, (or North mountain as it is called.)

§. 353. Going east from Shinersville, to and through the Green settlement, the main road is always in *Pocono sandstone* (X), and the *Shinersville conglomerate* is far south of it; indeed the conglomerate must cross Birch creek not more than one or one and a half miles east of Shinersville, and after that is exclusively to the south of Birch creek.

On the main road, masses of *Shinersville conglomerate* are found loose at Obert's school-house, 4½ miles east of Shinersville; and from there on to the southeast, pieces are found along the roadside.

§ 354. *East end of the coal basin.*—It is clear that the Bernice basin, as a coal producing basin, has pinched itself into a canoe shaped point, and the productive measures have stopped somewhere between the opening on coal bed B on Pigeon creek and where the centre of the synclinal crosses the Lee settlement road in the vicinity of Siglinger's house. For at that point the coal measures are wanting, and the massive Shinersville conglomerate is found in the hillsides and tops, and the red colored wash from the underlying rocks of XI covers the road and surface of the valleys.

§ 355. Between the forks of Rocky run the massive conglomerate pieces are on the hilltop; they are on the divide between Rocky and Santee runs; and on the hilltop on the road just south of Bendorf's house or one half mile south of the south fork of Rocky run where it crosses the Lee settlement road.

At the Lee settlement school-house the measures are clearly those underlying the *Shinersville conglomerate.*

South of Birch Creek.

§ 356. *Conglomerate.*—On the south side of Birch creek, in a railroad cut, just west of the Susquehanna and Berwick turnpike, and about 35 feet above the level of Birch creek, there is an exposure of 10 feet of conglomerate rock, lying apparently flat, or with a dip so slight as not to be measurable; the rock is a mass of small rounded quartz pebbles, in a matrix of sandstone. But the whole mass is conglomerate, not merely a sandstone with conglomerate layers.

§ 357. A small knife edge layer of *coal* is found in the centre of this conglomerate mass.

§ 358. This same *pebble rock*, of exactly similar character, is found exposed west of the Breaker mine, where it shows underlying the lower coal bed.

This (top of XII) conglomerate layer is not thick: probably not exceeding in this region more than 25 to 30 feet.

Above this conglomerate come in the Lower Productive Coal Measures, a vertical section of which has already been described.

§ 359. *Going south from Bernice* along the Susquehanna and Berwick turnpike, *coal* and *coal slate* have been thrown out from a shallow pit on the road side just east of and near Bernice. The level is over 1860′ above ocean and the opening is on the top bench of coal of the Big Bed.

§ 360. *Coal A?*—A broad flat stretches for the greater part of a mile across the hill top to the southward, heavily covered with loose stuff: and then on the road side there is again *coal slate* and *coal* from a shallow pit; probably an opening on the lower coal bed.

§ 361. *Conglomerate* rock shows in place on the crest of the hill, on the Loyalsock side, 1840′ feet above the ocean and 270 above the Loyalsock creek. This is apparently the top layer of the Conglomerate of XII: it shows as a somewhat massive sandstone, with small rounded pebbles scattered thickly through the whole mass: but with no regular layers of pebble rock.

From the conglomerate down to the Loyalsock creek the surface drift is so heavy as to render all exposures very imperfect: but it looks as though the upper 200 feet of the hill side were made up of thin bedded and massive gray sandstones.

No rock exposures are to be found on the Loyalsock creek, at water level, where the turnpike crosses it. It is clear however from some exposures south of the creek that greenish gray current bedded sandstones would be the rock in place at water level.

§ 362. *Lime rock in X.*—The calcareous siliceous rock opened on the south side of the Loyalsock creek, not far from Schreyfogel's hotel, already described, is clearly in the Pocono group.

Resumé.

§ 363. The measures exposed in the Bernice basin are:

XIII. Lower Productive Coal Measures, up to the big bed B,—a bed beneath it, called for convenience bed A,—interval rocks, above between and below the coal beds, mostly sandstone,—no limestone known,—total maximum thickness somewhat more than		100′
XII. Pottsville Conglomerate, nowhere sufficiently exposed to show the exact character of all the layers, yet plainly divisible into three members, thus:		
c. An *upper conglomerate*, commonly a mass of small pebbles cemented in a matrix of sandstone,—including at least one small coal bed, an inch or two thick—the whole mass rather crumbly and making neither cliffs nor bowlders—thickness not more than .	30′	180′
b. A *middle member*—in some places of massive sandstone—in most places somewhat thin-bedded, with some slaty sandstone layers—about .	100′	
a. A *lower conglomerate*—the lowest layers of which form the cliffs at Shinersville—breaking off in huge cubical masses—with inter-layers of pebbles, some of them large—thickness not less than (*Shinersville conglomerate*), ...	50′	

XI. Mauch Chunk red shale, probably not exceeding . . 25′
X. Pocono sandstone, thin-bedded and current-bedded, gray, and greenish, (with reddish layers occasionally,) only locally and partially exposed, thickness not obtainable here.
XI. Catskill red and gray sandstones and shales, badly exposed, down to the level of the water courses.

For a better description of IX and X see the following chapter on the rocks of the North Mountain plateau.

§ 364. The following tabular resumé of the coal analyses given in the foregoing pages will be convenient:—

Coal from Bed B—the Big Bed.

	Water.	Vol. matt.	Fix. carb.	Sulph.	Ash.	Color of ash.
Upper bench, ...	1.840	9.835	76.788	.647	10.890	cream.
Middle bench, ...	1.800	9.650	82.373	.622	5.555	gray.
Lower bench, ...	2.200	9.405	81.267	.618	6.490	cream.
Average of all, ...	1.295	8.100	83.344	1.031	6.230	gray.
Pigeon creek, ...	2.340	8.440	80.949	.726	7.545	cream.
Coal from Bed A.						
Jackson opening, ...	4.130	15.270	67.362	.523	12.715	reddish gray.
Coal not identified.						
1½ miles E. of Bernice, Upper bench,	7.930	21.410	54.099	.551	16.010	cream.
Lower bench,	2.910	11.780	81.672	.598	3.040	cream.
½ mile E. of Bernice, Probably bed A, ...	4.810	14.085	64.436	.549	16.120	reddish gray.

CHAPTER III.

The North Mountain Plateau.

§ 365. *Pocono rocks.*—Going south from the Loyalsock creek, on the Susquehanna and Berwick turnpike, imperfect exposures are found on the hillside south of the creek ; but sufficient is visible to make it clear that thin bedded current bedded greenish sandstones, with an occasional softer sandy slate layer, make up the country rock until near the hilltop ; the crest of the hill, 300 feet above the level of the Loyalsock creek, is made of massive sandstone with some thin bedded layers. All these measures are dipping to the northward to go under the Bernice basin, and the whole hill is composed of rocks of the Pocono formation, or No. X.

§ 366. *Iron ore.*—One and a half miles south of the Loyalsock creek, and two miles north of Lopez creek, the roadside exposure shows loose specimens of the deep red colored "iron ore" which lies directly under this massive sandstone of X.

§ 367. *Sub-anticlinal.*—Here is plainly a subordinate anticlinal ; for, one mile further to the south, and 170 feet higher in level, the hill crest, one mile north of Lopez creek, is made up of this massive sandstone of X in place. But the sandstone crowns the very crest of the divide, and the highest rocks geologically on this part of the plateau belong to the Pocono group.

Another summit, only one half of a mile north of Lopez creek, has this massive sandstone for its crest.

§. 368. No rocks show in place in the valley of *Lopez creek*, but on the divide between Lopez creek and *Painter Den run*, the same massive sandrock, somewhat conglomeratic, again shows on the crest, making small cliffs, and breaking off in great blocks and masses. The slopes of the hillsides from the crest down to the valley bottom are covered so deep with glacial drift as to offer no chance for rock exposures in place.

§ 369. There are no rock exposures on *Painter Den run;* on the next small divide to the south, nor on Spring brook.

§ 370. At a point about one half of a mile south of Spring brook, still on the Susquehanna and Berwick turnpike, and two and one half miles north of Ganoga lake (Long pond) the same massive sandrock is exposed, breaking off in blocks and masses.

§ 371. *Iron ore.*—Directly under it is a bed of *iron ore,* somewhat siliceous, apparently of fair richness in iron: only a few loose pieces were found, and no opening has ever been made on the ore, which may be only a few inches in thickness.

Below this ore there is a deep red colored soft rock, nearly like chalk in softness, and weathering down into a smooth red mud.

§ 372. *An anticlinal axis* plainly crosses the turnpike near Spring Brook, three miles north of Ganoga lake (or Long pond). The axis has a course of nearly east and west.

§ 373. *The Ganoga basin* as it may be called, between Spring brook and the escarpment of the Allegheny (or North) mountain is of a very simple structure. The centre of the synclinal is at or near Ganoga lake: the rocks rising gently to the north or to the south from that place,—but very gently, for the top of the massive conglomerate sandstone of X, which shows at the head of Fishing creek gorge, near the hotel, is 130 feet ± below the hotel itself, and the bottom of the same sandstone is perhaps 250 feet below the hotel.

Now at the outcrop of the bottom of this massive sandstone near Spring brook, the bottom of the sandstone is only 115 feet below the hotel. It has therefore risen to the north 135 feet in 2½ miles: and the rocks are still rising gently to the north at the exposure at Spring brook. The anticlinal axis however cannot be far from the exposure.

The basin is equally simple to the south of Ganoga lake. The rocks rise very gently to the south, and their outcrop is plainly seen on the North mountain escarpment.

The whole Ganoga basin is made up of the rocks of the Pocono formation, No. X.

§ 374. *The anticlinal and synclinal axes of the North mountain* plateau run about north 75° east and south 75° west.

§ 375. *Glacial striæ.*—One mile north of Ganoga lake some well defined glacial scratches show on the road side. The ice mass came from the north 20° east; and many parallel scratches are found, trending in all cases to the south 20° west.

§ 376. *Ganoga Section.*—The rocks in and under the Ganoga basin are comparatively well exposed in different places on the escarpment of the mountain and in the gorges, as well as by some borings made by Col. R. B. Ricketts, near Ganoga lake. The following section is exhibited along the main turnpike road on the mountain face: Sec. 45, fig. 57.

X.	Massive sandstone, conglomerate layers, breaking off in huge blocks, making mountain crest.	
	Red rocks, usually soft,	25′
	Red sandstones and slates, with some few gray sandstone layers interleaved,	70′
	Reddish and some grayish sandstone,	35′
	Gray sandstone, thin bedded usually, enormously current bedded, making great cliffs along the roadside,	255′
	Red sandstone and interleaved red shale,	60′
	Gray and greenish slates,	5′
IX.	Red and brown sandstones, with layers of shales running in color from deep red to brown; with a very ferruginous slate at the bottom, nearly rich enough for an iron ore,	250′
	Red shales, very soft and easily disintegrated,	35′
	Red sandstone, thin bedded,	10′
	Deep red-colored slates,	80′
	Total,	825′

§ 377. *Pigeon run and Fishing creek section.*—A vertical section made from the head of a branch of Pigeon run down to Fishing creek, and then up the latter, gave the following imperfect section of the measures below the bottom of the massive sandstone layer. But the section is so imperfect as not to show the junction of the red and gray rocks; and, in fact, red and gray rocks are in many places closely interleaved.

Massive sandstone; makes cliffs; filled with layers of pebble rock; seems to be at least,	120′
Red shale, soft, holding ball iron ore; concentric layers; lumps of ore very numerous; grey nodular ore. Thickness of shale,	10′

§ 378. *Iron ore.*—A specimen of the iron ore in the red shale, directly underlying the massive conglomeratic layer of X, was analysed by Mr. McCreath, who thus reports the results:

"A coarse-grained, hard and tough, greenish-grey carbonate ore.

Metallic iron,	20.575
Sulphur,	.007
Phosphorus,	.386
Insoluble residue,	46.650

§ 370. *Fishing creek gorge makes* exposures of some geological interest, but affords no connected section.

Coal slate in X.—About 150 feet± below the bottom of the massive sandstone there is an exposure of highly carbonated slate, with red shales above and below.*

The lower layer of the slate is 2 feet thick; a dark blue-black carbonated aluminous coaly slate, filled with impressions of calamites and lepidodendron.

The lowest two feet are the richest in carbonaceous matter; above that there are 7 feet of clay slate, gradually growing less deeply colored, with a reddish-gray slate and shale coming in on top of them.

Limestone of X.—About 600 feet± below the base of the massive sandstone in X is a massive *limestone*, fully 12 feet thick. It is chiefly a sandy calcareous rock; but layers of it are made up of rounded pebbles of carbonate iron ore, held together by a matrix of calcareous matter.

The limestone when burned slacks very well.

It could not be determined from the weathered outcrop whether the rounded iron ore pieces came water-worn from some other locality or were concretions formed in place.

Conglomerate of X.—The massive sandstone in X is well exposed at the head of the gorge of Fishing creek, about one half of a mile from Ganoga lake. A cliff of the rock stands vertically 80 feet high at the head of the cañon. The sandstone is massive, with many conglomerate pebble layers; is grayish in color, and breaks off in huge blocks.

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*These vespertine coal and coal slates are more fully described in the report on Lycoming county, GG. First part of this volume.

Coal bed in X.—A small bed of coal, not six inches thick on the average, shows in the face of the cliff, with massive sandstone enclosing it above and below. The coal bed varies in size with great rapidity and can be seen changing its size every few feet; a striking exhibition indeed of the uncertainty to be expected in mining any coal bed which has a roof and floor so abnormal as a massive sandstone.

This coal bed probably swells up in places to a greater size; and the presence of its smut on the crop in places when it may be more than 6 inches thick has doubtless assisted in making a misconception concerning the presence of the lower productive coal measures on the North mountain.

§ 380. *Daddow coal bed in XII.*—The small coal bed opened up years ago at the "*Daddow mine*," the "*Miller mine*," east of Pigeon creek and on Birch creek is probably the small coal bed which at Bernice shows in the conglomerate of XII near the level of Birch creek.

It is reported that at these mines named above the coal averaged 20 inches thick; sometimes running as high as 2 feet thick; that all the openings are close to the top of the highest hills; that the coal bed carries a roof slate and a thin slate floor; and that from 40 to 60 feet of massive conglomerate sandstone overlie the coal, with as much more underlying it.

The openings named cannot now be examined, and are moreover in the midst of that magnificent unbroken forest which covers the North or Allegheny mountain plateau for a distance of 50 miles east and west by some 10 miles north and south.

§ 381. *The Allegheny mountain front.*—The southern part of the North mountain (or Allegheny mountain) plateau, that part which lies between the escarpment of the mountain and the anticlinal sub-axis four miles to the north, is a high broad mountain mass, nearly level on top, the summits being some 2,400 feet above the ocean level.

The massive sandstone of X, with its conglomerate layers, which shows so boldly in a cliff at the head of Fishing creek gorge, dips gently to the northward and comes up again to daylight, with a little of underlying red shale also exposed.

The plateau therefore is a very regular and shapely synclinal basin; the country rock over the whole area being the rocks of the Pocono group, or formation X.

§ 382. *Ganoga lake bore hole.*—Col. R. B. Ricketts put down at Ganoga lake a bore hole, 120 feet deep. It shows the character of the Pocono rocks for that distance: but as it was done with the old style of rods it afforded only imperfect specimens of the rocks penetrated.

The boring was made because the massive sandstone and conglomerate at the head of Fishing creek gorge had been supposed to be the Conglomerate of XII: and this bore hole at Ganoga lake was expected to pass through the coal measures as they exist in the Bernice basin. This expectation was not fulfilled. The rocks penetrated by the drill are Pocono rocks, to which group also the massive Fishing creek conglomerate rock belongs. The record of the *Ganogo lake* boring reads as follows: Sec. 46, fig. 58, page 210.

Surface, or length of box,	5′ 0″
Sandstone,	10′ 0″
Yellow ochre, and iron ore,	6′ 2″
Blue slate, and iron ore,	12′ 6″
Slate (some few small coal pieces),	13′ 6″
Black, soft, gritty rock,	3′ 10″
Sandstone, very hard, dark and fine grained,	1′ 4″
Slate (some few small coal pieces),	2′ 8″
Sandstone, very hard, dark and fine grained at top, but growing lighter towards the bottom,	16′ 0′
Slate,	1′ 6″
Sandstone, dark at top, but growing lighter colored towards the bottom,	5′ 6″
Slate,	3′ 6″
Sandstone, dark colored, hard, fine grained, micaceous,	4′ 3″
Slate,	1′ 0″
Sandstone, light colored, hard, fine grained, micaceous,	14′ 6″
Dark and light sandstones alternating,	18′ 9″
Total,	120′ 0′

§ 383. *The Pocono rocks* therefore in the centre of the Ganoga lake basin, lying directly on top of the massive *Fishing creek conglomerate*, are made up of sandstone layers with interleaved ochre beds, iron ores, and some carbonated slates.

Coal in X.—These latter have no value as coal beds; there are probably some streaks of coal through the mass of carbonated clay; but they can be of no more consequence than the streaks or small beds of coal found in other horizons of the Pocono sandstones, or than the little irregular and uncertain coal bed which occurs in the massive conglomerate sandstone at the head of Fishing creek gorge. It must be concluded that there are no Lower Productive coal measures and no workable coal beds on the North mountain plateau, south of the Bernice basin.

§ 384. The measures immediately above the top of the bore hole, as examined in the higher land *east of Ganoga lake*, are composed of about 100 feet of thin bedded sandstones, sometimes conglomeratic: apparently almost entirely sandstone, with very few softer layers interleaved. There was no outcrop show of coal seen on the North mountain plateau excepting those already described above.

§ 385. *The iron ore* of the vertical section, underlying the ochre bed, shows thus:

Good bluish iron ore, (under the ochre,)	0′ 6″
Small slate parting.	
Red sandy ore, leaner in character, ...	6′ 0″+

A specimen of the good bluish iron ore was forwarded to the laboratory of the Survey, and yielded, on analysis, (McCreath):

Sullivan county, near Ganoga Lake, (Long Pond): "Carbonate ore, more or less oxydized; color, greenish-gray to reddish-brown.

Metallic iron, ...	32.000
Sulphur, ...	.040
Phosphorus, ...	.204
Insoluble residue, ...	19.420

This represents an iron ore of fair quality, the sulphur being unusually low, and the phosphorus not high.

An average specimen of this same ore was analysed by Mr. J. Blodget Britton, with the following results:

Volatile matter, (water and carbonic acid,)	17.66
Insoluble siliceous matter,	20.00
Pure iron, in the form of protoxide,	9.73
Pure iron, in the form of sesquioxide,	24.65
Oxygen with the iron,	13.77
Alumina,	6.40
Lime,	.95
Magnesia,	1.08
Sulphur,	.02
Phosphorus,	.04
Oxyde of manganese,	4.90
	99.20
Metallic iron,	34.38

The above analysis represents a moderately valuable iron ore; one which could be used for mixing with richer ores in making pig iron for the use of Bessemer steel works.

A specimen of the ore which overlies the yellow ochre deposit was forwarded to Mr. McCreath, who reports the results of his analysis, thus:

A carbonate iron ore; more or less oxydized; coarse-grained; sandy; greenish-gray and reddish-brown in color.

Metallic iron,	15.950
Sulphur,	.012
Phosphorus,	.076
Insoluble residue,	62.890

The above is too poor in metallic iron to pay for working.

§ 386. *The ochre bed* is fully four and a half feet thick. Two shafts have been put down upon it, a half a mile apart. It shows about the same measurements in both cases. "The ochre has been pronounced by experts and dealers one of the finest in the market."*

The upper part of the ochre bed appears to be the purer of the two.

The sandstone directly overlying it is a fine-grained, quartzose rock, of bluish color, and ferruginous.

A layer of red sandy iron ore makes the bottom of the ochre bed.

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* This is quoted from a report made to Col. Ricketts, the owner of the property.

§ 387. An examination was made of the region for three or four miles east and east-north-east of Ganoga lake.

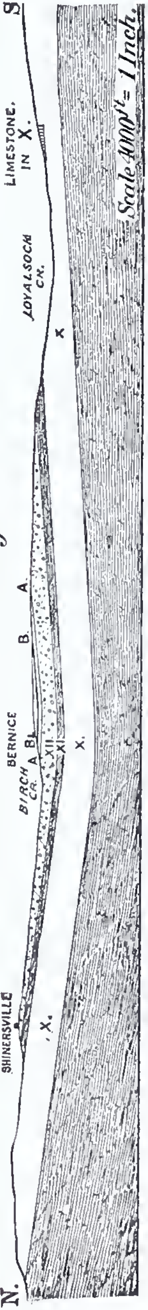
This is about the centre of the synclinal. The measures for 100 feet above the level of Ganoga lake were seen in several places, but in every case the country rock was fine-bedded sandstones, sometimes conglomeratic, without benches or show of softer rocks.

The great plateau of the North mountain is drained off towards the Susquehanna by the waters of Bowman's creek and the Mehoopany. These streams head up near Ganoga lake, run east parallel to each other and five miles apart, and empty into the Susquehanna, the one at Tunkhannock, the other at Mehoopany.

The rocks of the Pocono group, and the climate of this elevated plateau, have been favorable to the growth of one of the most magnificent forests to be found in this country. The great body of the region is covered with hemlock timber; but the ridges are covered with a luxuriant growth of ash, black and white birch, poplar, beech, maple, and cherry.

The scenery is of unusual beauty, the deep gorges of the mountain escarpment presenting some scenery scarcely equalled along the whole Allegheny mountain range through Pennsylvania. Already on the shore of Ganoga lake there is established a thriving summer resort. The climate resembles northern Maine; the plateau is so elevated above the sea, (2300 to 2400 feet,) and so broad, as to render the flora of the crest different from that of the valley at the foot of the mountain, and to make it allied to the flora of a latitude far to the northward.

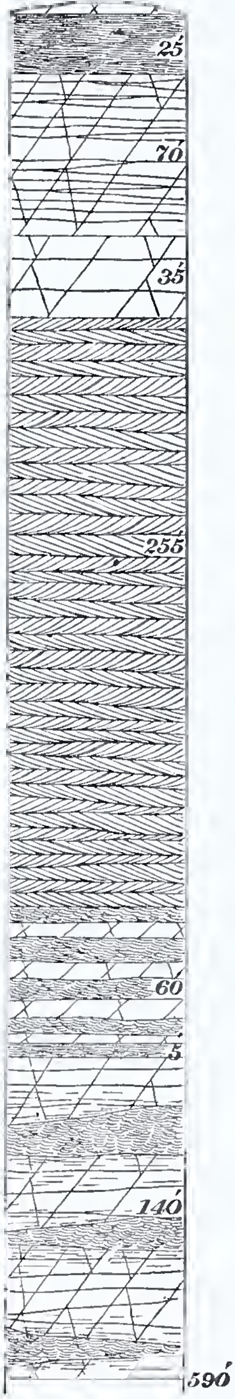
CG. 210.



Bernice Coal Basin. Fig. 56.

Ganoga; general section §376.

Sec. 45. Fig 57.



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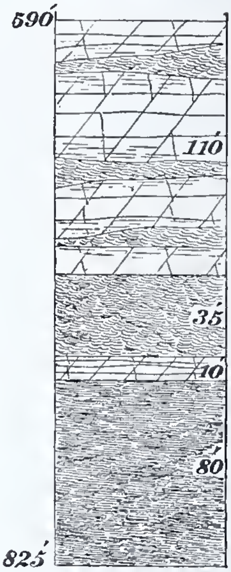
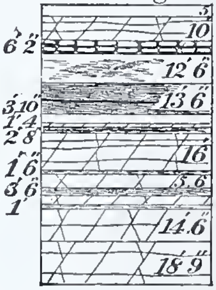


§ 382.

Sec. 46. Fig. 58.



CHAPTER IV.

From Bernice Westward down the Loyalsock.

§ 388. Two and one half miles west of Bernice, on the north side of Birch creek, just north of the Dushore and Laporte main road, the *Shinersville conglomerate* (XII*a*) crowns the hill top and makes an exposure in cliffs. It is of the same character as at Shinersville; a very massive sandstone, breaking in great blocks, and having its conglomerate as layers of pebble rock, not through the mass. The exposure here would indicate that only the lower 50′ to 80′ are conglomerate; above that the rocks are less massive sandstone, with layers of thin-bedded greenish colored sandstones.

§ 389. *Coal in XII a.*—In this conglomerate mass a small coal was once opened. It is *said* to have measured in one place twenty inches in thickness; but its average character is that of a small and uncertain coal bed, only a few inches thick.

The measures coming in on top of the *Shinersville conglomerate*, are thin-bedded sandstones, with an occasional softer layer of sandy slate, much of the rock being greenish colored and spotted.

The dip of these conglomerate rocks in these cliffs is into the Bernice basin, which is here pointing up into a canoe-shaped point; the level is about the same as the top of the Bernice hill; and the rounding off of the coal measures on the western end of the Bernice basin is plainly shown.

Directly north of this ledge of *Shinersville conglomerate* the Red shale of XI comes in and makes a clearly defined band around the northern edge of XII.

§ 390. *Meylert's coal.*—About seven or eight miles west of Bernice and 5 miles east of Forksville (in straight lines) there is an old opening on the Meylert property. It is 1 mile south-southwest of J. Cowley's house, close to the east boundary line of Forks township.

The opening is made on a high and rather narrow hill, and within 50 feet of the top of it: the surrounding region being somewhat lower in level.

The overlying 50 feet of rock are wholly or in great part conglomeratic sandstone.

The opening itself is not now worked at all and has fallen shut; The very imperfect exposure shows at the outcrop thus:

Dark clay slate overlying,	6′ 0″
Coal, (reported, *not seen*),	2′ 8″
Floor (fireclay ?)	

From the general appearance of the enclosing rocks it appears that this Meylert coal may be the same coal bed opened by Lippincott and Mercur, south of Forksville.

Is it either of the Bernice coals? The few small pieces of coal and slate lying near the mouth of the drift resembled somewhat the coal from the lower bed at Bernice, 60 feet below bed B.

In the absence of any openings or exposures in the vicinity, the region being forest with but few clearings, it is impossible to make a precise identification. I incline to the belief that the coal is simply a local coal in XII, and not the lower bed at Bernice.

Even supposing it to be the latter bed, as the opening is close to the top of the highest hill, and is nearly at the centre of the synclinal axis, there is small prospect for finding any area of Lower Productive measures in the vicinity.

So far as the weathered small pieces of loose coal will admit of description, it can be said that the Meylert coal is like a hard semi-bituminous coal: with no conchoidal fracture: is crumbly, and makes fine cubes: and in no sense looks like an anthracite.

Going north northeast 1 mile to Cowley's house, the ground rising slightly in that direction, the surface is covered everywhere with pieces of bluish colored conglomerate and conglomeratic sandstone.

§ 391. *At Laporte*, the entire hilltop is covered with bowlders of massive sandstone and conglomerate, in large blocks sometimes, but usually only in pieces of moderate size.

The conglomerate is blue-gray colored, with small pebbles of white quartz in layers; resembles very much in appearance the massive conglomerate layer in the Pocono group which shows in a vertical cliff at the head of Fishing creek on the North mountain plateau.

On the east side of Laporte the hillside down to Mill creek affords only an imperfect section; but shows enough to make it reasonably certain that for about 125 feet down from the flat hilltop on which Laporte is built, the rock is almost entirely sandstone, not usually in plates of more than three inches thick, and from that down to one inch or one half inch thick; the sandstone fine grained, non-conglomeritic generally where seen, sometimes a little crumbly, with a few small layers of softer sandy slate.

From this point down to the level of Mill creek, 50 feet, no rock shows in place.

While the exposures at Laporte are not complete enough in themselves to make a section, yet they indicate that the rocks are the same as those of the North mountain plateau, the Pocono formation, as already given in preceding pages of this report.

§ 392. *Hall's drift.*—One mile south of Laporte, on the Muncy road, a trial drift has been put into a small coal outcrop on the Sheldon Hall property.

The drift runs in north 55° west; is in over 125 feet, and found slate, with two small leaders of coal.

The coal seems to dip to the northwest, so far as they have followed it.

The mining has developed almost nothing but slate; very little coal having been found and that only in thin strings.

A trial shaft, starting in 10 feet above the mouth of the drift, gives 12 feet of clay, fireclay and loose trash; no solid rock in place over the coal.

The hill at its highest point is little more than 25 feet above the level of the drift.*

It is clearly a perfectly worthless local bed of slate, carrying some coal, and is in the horizon of the small coal show in X, at the head of Fishing creek gorge.

Twenty feet below the drift there is massive conglomerate sandstone in place; and under the sandstone a little red colored wash.

Some loose pieces of coal were picked from the tip at Hall's drift and forwarded to Mr. McCreath who reported:

"The coal has a deep black, dull lustre; it is rather friable; contains some slate. The coal does not show the slightest tendency to form a coherent coke; the volatile matter burns with a feebly luminous flame. The coal acts generally in the same way as that from the lower bed at Bernice, (that is, re-absorbs water on cooling, &c.):

Water,	6.830
Volatile matter,	21.930
Fixed carbon,	55.413
Sulphur,	.387
Ash,	15.440
	100 000
Color of ash,	red.

It will be noted that this is another of those remarkable coals containing a high percentage of water, which re-absorb this water again quickly in part, after it has been expelled at 212° temperature.

Leaving out the accidental impurities, and counting only the ignitible constituents, the composition is—

Fixed carbon,	71.646
Volatile matter,	28.354
	100.000
Or in the proportion of vol. matter to fixed carbon as	1:2.527

§ 393. *From Laporte west to Forksville.*—As already stated, the conglomerate pieces cover the whole hill on which Laporte is built; and going westward along the road the same rock is found crowning the hill tops for a long distance. The region is really a great plateau, the hills not high above the general plain, and the height being very regular.

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* It is reported that slate and some coal were found in a well at the hotel at Laporte. The level would correspond for its being this same bed.

At Celestia, on the summit between Celestia and Eaglesmere, (Lewis lake,) and on the boundary line between Shrewsbury and Laporte townships, the same surface show is found as at Laporte.

Crossing the lowest point between Celestia and Eaglesmere, 230 feet below Laporte, the sandstone is no longer found and red rocks of IX have come in, making a red wash everywhere over the soil; but on rising 100 feet up the hill the red rocks are again lost, and sandstone and conglomerate pieces make the surface rock of the Pocono formation.

The measures appear to be almost perfectly horizontal; a plateau of X, with the streams cutting through sometimes into IX.

At Eaglesmere (Lewis lake) sandstone pieces cover the surface; the lake shore is very pure sand, and glass works were established here by Lewis in 1798; the sand used in the works being taken from the end of the lake.

The old works are now entirely gone; but the place, which has great natural beauty, is being built up as a place of summer resort.

The lake is 1,726 feet above tide.*

Going west from Englesmere, on reaching the valley of the first stream, 210 feet below the lake, the red rocks of IX are the country rock; and also at Little's house at the forks of the main road; but 1 mile north of Little's house the same massive conglomerate sandstone crowns the hills as before; the basin being very regular, and the different rocks keeping their levels with much regularity.

From Little's house to Forksville the road follows the valley and keeps always far below XII.

§ 394. *Forksville* is on the west side of Forks township, and at the junction of the Big and Little Loyalsock creeks.

The hills on the south side of the creek are so covered with loose stuff as to prevent any vertical section of the measures from being obtained; obscuring the bed rock so completely as to allow no exposure of the junction of IX and X, X and XI, XI and XII, all of which junctions are on this hillside.

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*Report N, second Geo. Surv. of Penn., p. 146.

The hilltop is narrow, at its north point.

§ 395. *Warren and Wright's coal.*—Just under the bluff of sandstone which makes the hill crest, and 920 feet by barometer above the level of the Loyalsock creek, there is an opening on a coal and slate outcrop. It is called the Warren and Wright opening and shows: Sec. 47, Fig. 59.

Roof of sandstone, conglomerate, thin bedded, in 1 inch layers, iron stained, somewhat current bedded,	8″ to 0′ 10″
Slate,	1′ 8′ to 2′ 0″
Coal,	0′ 6″ to 0′ 8″
Slate,	1′ 6″ to 1′ 8″

Bottom rock not showing.

There are only from six to eight inches of coal in three and one half feet of slate.

The slate is tough and comes out hard to the outcrop.

The coal is hard, and seems slaty; but is only touched on the crop, and the opening is scarcely sufficient to justify any opinion concerning its quality.

The rock cover of the coal, which does not exceed 20 feet in all, is made up entirely of massive sandstone, with conglomerate layers; the rock is bluish and gray, with numerous pebble layers, and looks much like the Shinersville conglomerate, or bottom layer of XII.

The hill summit falls off quickly on both sides and the neck of high land is narrow; not more apparently than 300 yards wide of this high crest holding the coal.

§ 396. *Lippincott and Mercur mine coal.*—About three miles southwest of Forksville, and between 800 and 900 feet above the level of the Loyalsock creek, is the Lippincott and Mercur mine. It has only been mined in a very small way for local use in Forksville and the immediate vicinity.

The bed shows layers of coal as hard apparently as the big bed at Bernice, with intermingled layers of shining columnar coal. Very thin layers of slate are found running through the coal mass.

On top of the coal bed are 10 to 15 feet of massive conglomerate sandstone.

The hill rises for as much as 35 feet above the coal, apparently all sandstone; but this is the extreme thickness of cover, and any depression or stream which cuts down to that depth would reach the coal level, and cut it out. But the hilltop is a broad one, and very level, and the acreage covered by the coal bed is evidently considerable.

The section of the bed shows: Sec. 48, Fig. 60.

Covering rocks, sandstone,			20′ 0″
Sandstone conglomerate,			10′ 0″
Clay slate, deep black, tough, with one small ½ *inch coal* through it,			2′ 6″ to 3′ 0″
Coal bed.	*Coal* and slate,	0′ 6″	3′ 0″
	Coal, columnar,	0′ 6″	
	Coal, hard,	2′ 0″	
Slate,			3′ 0″
Floor not seen.			

"The main 2′ bench of the coal is hard, dull looking, without any columnar structure; and is mined and burned as anthracite, in the ordinary anthracite stoves, while the upper 6″ bench of columnar coal is kept apart and used by blacksmiths."

The above statement of the uses made of the coal is made by Mr. Randall, yet the analysis shows scarcely any difference between the two layers, the difference evidently being simply one of physical structure.

It is clear that the size of the coal bed is not sufficient to give it any commercial importance for shipment to other regions, but it is of value for supplying the local demand.

Specimens of the upper and lower benches of this coal were forwarded to Mr. McCreath, who reported thus:

"Sullivan county, 3½ miles southwest of Forksville, coal from Lippincott and Mercur's mine. *Upper part* of bed.

The coal has a deep black shining lustre, is rather tender, and contains thin bands of bright crystalline coal and slate. It seems in the main free from iron pyrites.

Water at 225°,	0.930
Volatile matter,	12.410
Fixed carbon,	75.611

Sulphur,	.574
Ash,	10.475
	100.000
Color of ash,	grey.

The *lower* (or 2 foot) bench showed, on analysis:

The coal is compact and brittle, with a deep black to greyish black lustre. It contains numerous bands of slaty coal, and seems, in the main, free from iron pyrites. The coals (upper and lower bench) do not yield a coke. The volatile matter burns with a bright yellow flame.

Water,	0.810
Volatile matter,	13.030
Fixed carbon,	71.679
Sulphur,	.581
Ash,	13.870
	100.000
Color of ash,	grey.

Leaving out the accidental impurities of these coals and counting only the ignitible constituents, their composition is, for the upper bench of coal:

Fixed carbon,	85.901
Volatile matter,	14.099
	100.000

or in the proportion of

Vol. matter to fixed carbon, ... as 1 : 6.092

and for the lower bench of coal the composition is:

Fixed carbon,	84.588
Volatile matters,	15.412
	100.000

or in the proportion of

Volatile matters to fixed carbon, ... as 1 : 5.488

The coals therefore are about half way between the Bernice anthracite and a semi-bituminous coal: they are a semi-anthracite. The same coal bed is opened at the New Mercur mine about 1 mile east of the Lippincott and Mercur opening.

§ 397. The absence of any good section on this *Forksville hill* renders it difficult to make any certain identification of the Lippincott and Mercur coal. From some imperfect exposure of some red rocks on the hill side only 190 feet below the coal it is clear that it is scarcely high enough above XII to be in the true Lower Productive Measures: and the uncertainty of the bed itself, its appearance as a mass of slate holding coal only two miles away, confirms the opinion as to its geological horizon, that it is a local coal in the sandstone of XII, and is not the same bed as either of the coal beds at Bernice. It may however be coal bed A of the Bernice basin. The so-called Randall mine must be only an opening on a crop of coal and slate in X. It is far below the coal of XII.

§ 398. *Vertical Forksville section.*—The north side of the Loyalsock creek afforded an opportunity to procure a vertical section of the measures below XII: not showing all the rocks in detail, but giving an idea of the average thickness of the different formations in this region.

The Catskill is the country rock along the creek at Forksville: showing about 60 feet of it in a cliff just at the village.

The rock is conspicuously deep red in color: no fossils showing in it so far as examined: sometimes made up of hard sandstone, but as a rule red clay slates are the prevailing rock.

In all there are nearly 400 feet of Catskill rocks above water level at Forksville.

The Pocono rocks come in on top much covered by débris: gray colored usually, though sometimes greenish gray: generally enormously current bedded.

Mr. Randall reports that in blasting out rock on the top of the Catskill and the bottom of the Pocono (in a side cut for a road) they came not infrequently upon small layers and pockets of coal.

And Dr. Randall has driven into a small coal, fifteen inches thick in the Pocono rocks, on the south side of the Loyalsock, southwest of Forksville.

These are the representatives of the Vespertine coals of the East Broad Top region in Huntingdon county; of the Vespertine coal opened on the escarpment of the Allegheny mountain, back of Tipton, in Blair county; and of the small coal show on the North mountain plateau.

Going up the hill along the road on the north side of the Loyalsock creek opposite Forksville, the road is colored deep red, and occasional outcrops of red sandstone and red slates show for 380+ feet above the level of the Loyalsock.

Then the Pocono begins: and shows as a fine grained, thin bedded, and current bedded sandstone.

Brown's summit, a notch in the Bear mountain at this place, is in the Pocono rocks.

These rocks keep the same characteristics as they are followed up along the side of Bear mountain; always thin bedded and current bedded: and they continue on up to about 750 feet above the Loyalsock creek.

The exact point of junction between the Pocono group and the overlying red rocks does not show; but above this point (750 feet above the creek) the soil is deep red and such imperfect exposures as can be found are all of red rocks. This continues on to the hilltop 890 feet above the level of the creek.

The rocks are plainly dipping gently to the southward, towards the Forksville coal opening.

In the layers of Catskill it is to be noted that there are many gray sandstone layers, sometimes thin bedded and occasionally massive, which resemble closely the Pocono rocks; but the average mass is reddish colored and not so hard and massive as the Pocono group.

And in the Pocono rocks, while thin bedded gray and greenish sandstone is the general character of the measures yet there are numerous small layers of red sandstone and slate which come in at times and color deep red streaks along the face of the gray rocks.

The overlying Mauch Chunk rocks, are mostly red colored; but layers of hard thin bedded sandstone come in the near the top of the group, and spreading over the fields, make so much show in the midst of the soft slates as to appear much thicker than they really are.

The top of the red shale, on the north side of the creek is 890 feet above the Loyalsock, and only 30 feet below the level of the coal opened on the hillside, south of the creek; but the north side does not catch any of the conglomerate of XII, nor of the coal.

Allowing for slight differences in barometrical measurement in returning down from the hilltop to the Loyalsock creek, the *section at Forksville*, taking in the measurements on both sides of the creek, and compiling therefrom, is about thus: Sec. 49, Fig. 61.

XII.	Conglomerate sandstone,	35′ 0″
	Coal,	6″ to 2′ 6″
	Conglomerate and massive sandstone,	100′ to 150′ 0″ (?)
XI.	Mauch Chunk red shale,	100′ to 140′ 0″
X.	Pocono formation,	370′ 0″
IX.	Catskill rocks to creek level,	400′ 0″

The sub-division of the lower 770′ of this section into *Pocono* and *Catskill*, is made solely upon the color of the rocks and their character, in the absence of observed fossil forms. It is possible that the true separation between the red and gray may be at the top of the deep red soft rocks 50 feet above the creek level at Forksville; in such case there would be only 50 feet of *Catskill* and 720 feet of *Pocono* rocks. The discussing of this and allied questions comes in other parts of this volume, when all the measures from the Chemung up to the conglomerate of XII are discussed.

§ 399. *Limestone quarry at Millview.*—Millview is up the Loyalsock from Forksville, and two miles north-northeast of it.

About half a mile north of Millview, on Mill creek, Mr. William Lucke has opened a quarry in the lowest of three* widely separated exposed outcrops of limestone strata, dipping 7° more or less, southward.

1. Limestone at Mr. Lucke's house, 200′ above the quarry rock.
2. Limestone at the kiln, fully 85′ above the quarry rock.
3. Limestone in the quarry.

Without a more perfect section it would not be possible to locate precisely the horizon of these limestones; but from the structure it seems certain that the uppermost layer of limestone is at least 500± feet below the red rocks which show in the creek bank at Forksville.

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* Mr. Lucke reports that there are several small beds of limestone in the hill between the upper and lower of the limestone beds named above.

The north dip comes in about half a mile north of this quarry; making the anticlinal axis pass not far to the north. This is stated by Mr. Lucke.

The limestone layers of the quarry are thus arranged: Sec. 50, Fig. 62.

Small limestone layer, blue,	2′	0″
Red sandstone,	8′	0″
Limestone,	2′	6″
Slate,	2′	6″
Limestone,	3′	0″
	18′	0″

The slate thins down at times in the quarry to less than one foot in thickness.

Specimens of the upper and lower benches of limestone from the quarry were forwarded to the Laboratory of the Survey, in Harrisburg. They were analysed by Mr. S. S. Hartranft, and yielded thus:

	Upper.	Lower.
Carbonate of lime,	80.393	69.000
Carbonate of magnesia,	5.653	5.387
Carbonate of manganese,	3.116	1.689
Sulphur,	.240	.092
Phosphorus,	.133	.144
Oxide of iron and alumina,	5.196	5.870
Insoluble residue,	5.240	17.850
	99.971	100.032

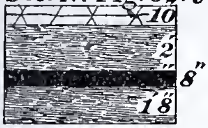
The upper layer represents a very good limestone. When burned it slacks well and is a valuable lime for agricultural purposes; a matter of considerable consequence in this region, where the soil needs a lime treatment.

§ 400. *Galena.*—Some small specimens of lead ore are found in the upper layer of limestone at the quarry; only in very small pieces, not in any regular deposit; and occasionally there are thin layers of limestones crowded with fossils.

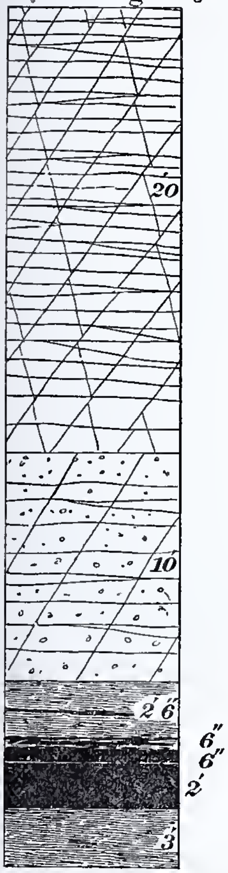
From Forksville to the Lycoming County Line.

§ 401. The main road from Forksville down the Loyalsock creek keeps in nearly the same measures for many

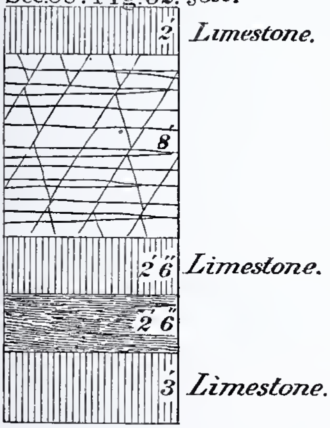
Sec. 47. Fig. 59. §395.



Sec. 48. Fig. 60. §396.



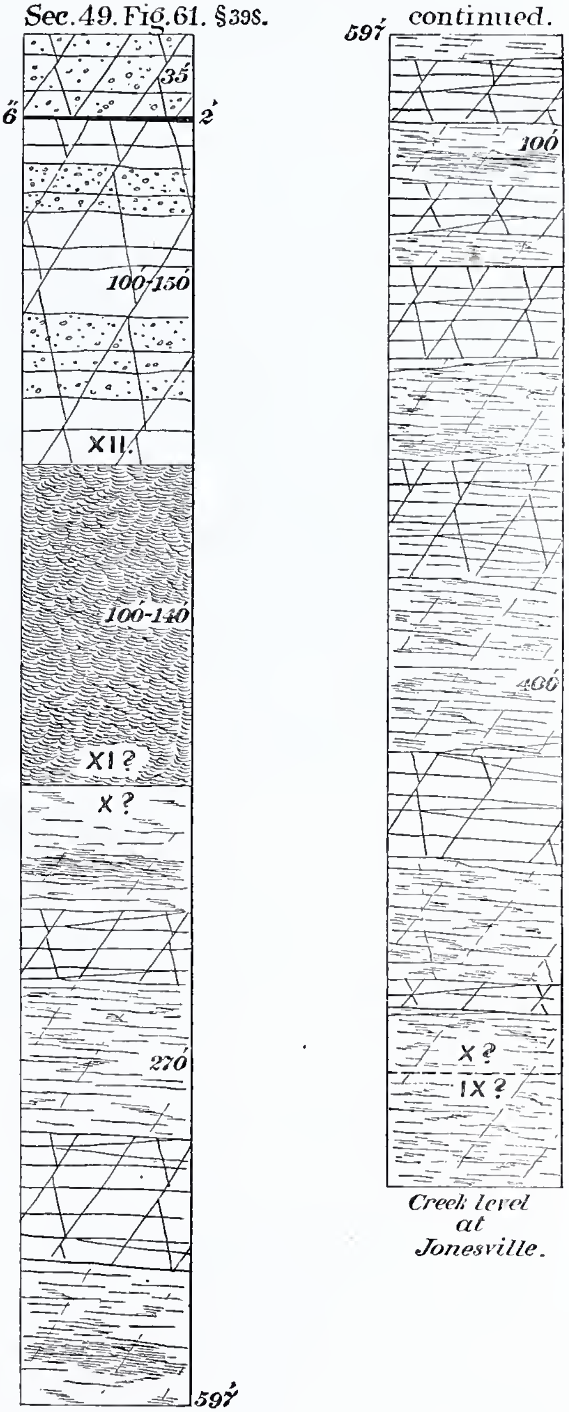
Sec. 50. Fig. 62. §399.



general section

Sec. 49. Fig. 61. §398.

continued.



miles; for the general course of the stream is about parallel to the trend of the anticlinal and synclinal axes and the fall on the Loyalsock is very gradual.

At Hillsgrove a thin-bedded and much current-bedded sandstone shows some fifty feet above the creek, with red slates above and below it. It is somewhere about the same geological horizon as at Forksville. Hillsgrove is 150 feet lower in level than Forksville.

There is no sign at all that any of XII catches in the hill tops at Hillsgrove; it would not be caught, indeed, at Hillsgrove, but on the hills to the south of it. If there be any of XII or its coal, caught on any extreme hill top, it would most probably be somewhere about the head waters of Dry run; but there is no report of any outcrop of coal having ever been found on the hills in that vicinity.

From Hillsgrove the main road going west leaves the creek and strikes over the hill top.

Red rocks (the Catskill) are on the summit, two miles away, fully 700 feet above the creek; and also at the county line, (Lycoming and Sullivan boundary line,) three miles west of Hillsgrove.

CHAPTER V.

On the variation in character and composition of coals from the four basins in Sullivan, Lycoming, Bradford, Tioga, and Potter counties, across the strike.

§ 402. The four basins referred to are 1. The *Bernice*, in Sullivan; 2. *Barclay*, in Bradford; 3. *Blossburg*, in Tioga; and 4. *Gaines*, (or Pine creek,) in Tioga and Potter counties.

§ 403. In the *Bernice* basin, we have an opportunity of studying only what is left of the coal beds in a small, regular, canoe-shaped synclinal area between Birch creek and the Loyalsock, as described in the foregoing pages. The measures from the coal down being conformable and almost undisturbed; no dip greater than 5°, and that local; no faults known; the coal beds variable in thickness, and the partings very variable:

One large coal bed (B), with three benches, separated by slate and clay; in some places worked together; in others far apart:

A small bed (A) 40 to 60 feet beneath B; interval rock:

A coal bed, 1½ miles east of Bernice, which may be one of the benches of B.

A coal bed, 3½ miles southwest of Forksville, possibly on top of XII; probably in the body of XII.

The constitution of these coals are shown in the following analytical table:

	1.	2.	3.	4.	5.	6.
Water,	1.295	1.840	1.800	2.220	1.950	5.815
Volatile matter,	8.100	9.835	9.650	9.405	9.030	15.085
Fixed carbon,	83.344	76.788	82.373	81.267	63.795	62.329
Sulphur,	1.031	.647	.622	.618	.585	.474
Ash,	6.230	10.890	5.555	6.490	24.640	16.297
	100.000	100.000	100.000	100.000	100.000	100.000
Color of ash,	Gray.	Cream.	Gray.	Cream.	Cream.	Reddish gray.

	7.	8.	9.	10.	11.	12.
Water,	4.130	2.340	7.930	2.910	.930	.810
Volatile matter,	15.270	8.440	21.410	11.708	12.410	13.060
Fixed carbon,	67.362	80.949	54.099	81.672	75.611	71.679
Sulphur,	.523	.726	.551	.598	.574	.581
Ash,	12.715	7.545	16.010	3.040	10.475	13.870
	100.000	100.000	100.000	100.000	100.000	100.000
Color of ash,	Reddish gray.	Cream.	Cream.	Cream.	Gray.	Gray.

1. The run of the mine, } B. } at Bernice.
2. Top bench,
3. Middle bench,
4. Lower bench,
5. Cannel in top bench,
6. Coal 60′ below B,= } A.
7. Coal 60′ below B,
8. Coal B, on Pigeon creek, 4 m. E. of Bernice.
9. Top bench, } B, 1½ m. E. of Bernice.
10. Bottom bench,
11. Top bench, } Coal 3½ m. S. W. of Forksville.
12. Bottom bench,

With these may be compared the following analysis of coal from a bed opened one mile south of Laporte, probably in *Pocono measures*, *X*.

Water,	6.830
Vol. matter,	21.930
Fixed carbon,	55.413
Sulphur,	.387
Ash,	15.440
	100.000
Color of ash,	red.

It will be seen, then, from the above analysis, that the most striking features of the Bernice basin coal are as follows:

a. The coal of bed B is a genuine *semi*-anthracite in composition, but not in appearance and fracture; lacks the brilliant anthracite luster, but is black; has no conchoidal fracture; breaks irregularly, with a tendency to a cubical (hard, semi-bituminous) fracture; composition closely resembling that of the Lykens Valley coal of Dauphin county (which comes from near the base of the conglomerate, XII); burns like other anthracites, and is classed with them in the market.

b. The coal of bed A, 60′ below B, belongs to the semi-bituminous class; has more water of composition; re-absorbs water rapidly on cooling; and does not coke.

c. The coal bed 1½ miles east of Bernice, has a semi-bituminous *upper bench*, and an anthracite, or semi-anthracite, *lower bench* separated by only 6′ of slate; the semi-bituminous coal holding more water in composition; re-absorbing water rapidly on cooling; and exhibiting no tendency to coke.

d. The Forksville coals have the dull, black luster and fracture of the hard, semi-bituminous coals; but in composition stand midway between them and the Bernice anthracites.

e. The Laporte coal, although lower in the measures, and older, is a real bituminous coal (22 per cent. vol. mat.), with much water (6.8 p. c.), rapidly re-absorbing moisture on cooling, and not coking at all.

§ 404. The *Barclay*-McIntyre basin, next north of the Bernice, is separated from it by a wide, low-arched anticlinal; exposing Chemung rocks on its crown; with gentle dips both ways; conformable rocks; no faults or disturbances of any kind visible.

Yet the same bed B, which in the Bernice basin yields a *semi-anthracite* with fixed carbon to volatile matters as 1 : 10.2893, yields in the Barclay basin semi-bituminous coal, with the proportion 1 : 4.0939.*

§ 405. The *Blossburg* basin, next north of the Barclay, is separated from it by a narrower and steeper anticlinal, with dips rising locally to 30°, bringing up the Chemung rocks on its crown; no faults or remarkable disturbances known to exist.

Its coals are also semi-bituminous, with the proportion 1 : 3.4939.†

§ 406. The *Gaines* basin, next north of the Blossburg, is separated from it by the wide and gentle Wellsboro'-Mansfield anticlinal, exposing half of the Chemung measures.

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* See analyses in Report G, page 140.

† See analyses in Report G, page 197.

Its coals are bituminous, with the proportion 1 : 1.9643.*

§ 407. *The progression from anthracite to bituminous* in a direction across the basins northward (or northwestward), from Bernice, in Sullivan, to Gaines, in Tioga and Potter, a distance of 50 miles, is evident, the proportion of volatile matter to fixed carbon in the different basins being:

In the Gaines basin,	1:1.9643
In the Blossburg basin,	1:3.4939
In the Barclay basin,	1:4.0939
In the Bernice basin,	1:10.2893

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* See analysis in Report G, page 234.

Chapter VI.

Which is the First Basin?

§ 408. Throughout this report it has been taken for granted that the Barclay basin in Tioga county is the far east or northeast end of the First bituminous coal basin of northern and western Pennsylvania; that it is continued westward through Lycoming county under the names of the McIntyre basin, and the Little Pine creek basin; and that the report of Clinton county will show it to be the Queen's run and Tangascootac basin just behind the crest of the Allegheny mountain opposite Lock Haven; whence it has been followed and described in the reports on Clearfield, Cambria, and Somerset counties into Maryland.

§ 409. When the names first, second, third, &c., were first given to the northern basins by Mr. James T. Hodge, assistant geologist of the first survey, in 1848, the connection across Lycoming and Clinton counties could not be made owing to the wildness of the region.

In Prof. H. D. Rogers' Final Report, Geology of Pennsylvania, 1858, the name First basin, given by Mr. Hodge to the Bernice and Laporte synclinal, was retained; and the Barclay basin of Bradford county (Towanda basin of the old reports) was also allowed to retain the name of Second basin given to it by Mr. Hodge. These were their proper designations for a geologist who commenced the survey, as Mr. Hodge did, in the east, and moved westward and southward. But when Mr. Hodge reached and crossed the west branch Susquehanna he was bound to apply the name First basin to the first basin lying back of the Allegheny mountain crest; and he did this without hesitation, for he had lost the connection in the wilderness of mountains and ravines through which he had been previously camping.

§ 410. The geological maps of Lycoming and Sullivan counties published with this report will bear their testimony to the insuperable difficulties encountered by the first survey, and to the doubts which still encumber the construction of a perfectly consistent and satisfactory nomenclature of our northern coal basin. For one difficulty is inherent. Subordinate anticlinals make their appearance, going west, and split up the basins; others die out westward and permit two basins to coalesce into one.

It seems certain, however, that the Bernice and other basins of Sullivan county terminate westward, and lie outside or to the south of the series of basins hitherto numbered from one up to six; and therefore, as has just been said, the First basin is regarded throughout this report as passing through McIntyre township, Lycoming county, to become in Bradford county the Barclay or Towanda basin.

§ 411. The First basin in its run through Somerset, Cambria, and Centre counties, is a double basin, the Allegheny mountain forming the eastern rim of the basin and Laurel hill the western; but right in the middle of this broad synclinal is a well-defined and continuous anticlinal, which sub-divides it into two basins, and on the Maryland line the First basin is made up of three sub-basins.

§ 412. The great anticlinal axis which is east of the Alleghany mountain, its huge original anticlinal arch now represented by the valleys of Morrison's cove, Canoe valley, Nittany valley, Nippenose and Mosquito valleys, dies down to the northeast, and already at Muncy the Upper Silurian measures begin to fold around it; gradually higher measures are taken in, until a huge and lofty plateau of nearly horizontal Devonian and Carboniferous rocks stretches out in front of its dying point.

In discussing the question of the anticlinal axis east of the Alleghany mountain and the anticlinals separating or sub-dividing the different bituminous coal basins, it must be understood that the eastern axis is so enormously greater than the others as scarcely to be measured in comparison with them.

For this great anticlinal axis brings up on its center the bottom of the Siluro-Cambrian limestone of II; and the

Pottsville conglomerate and Lower Productive coal measures, if they remained at any place on the center of the arch, world be some 25,000 feet above the sea; while in the synclinal basins to the west and east of this anticlinal (the Broad Top and Cumberland basins are east of it) the Pottsville conglomerate is between 1,000 and 2,000 feet above the sea. And this anticlinal arch, 25,000 feet high, was fully 40 miles broad across the base.

§ 413. But the anticlinal axes west of the Allegheny mountain are only about 5 miles broad from base to base, and elevate softly the Pottsville conglomerate for about 1,000 feet, the Pottsville being in the synclinals about that much lower than where it rides over the center of Laurel hill or Chestnut ridge; and the center of the arch does not run higher than about 2,000 feet above tide.

Laurel hill, which makes the western boundary of the First great basin in Somerset, Cambria, Centre, and Clearfield counties, continues on as anticlinal and crosses the Susquehanna. It has not been traced through Clinton county, nor can it be said that it is or is not the same as the mountains which make the northwestern boundary of the First basin in Lycoming and Bradford counties.

Chapter VII.

Persistence of coal characters along the strike, exemplified in the First Basin.

§ 414. In the face of the great and sudden change in the character of a coal bed in passing into another synclinal basin, it is interesting to note over how great areas a coal bed will retain its character *while going along the strike and keeping in the same basin.*

§ 415. Taking the analyses of çoal from bed B in these counties already published by this survey in its reports on Clearfield, Cambria, and Somerset counties, the result is an average of about 20 per cent. of volatile hydro-carbons to 70 per cent. of fixed carbon. And this average is well sustained; the variations from it being never great, and perhaps many of the variations due to imperfect specimens. It may be noted moreover that it is not necessary to confine the average to bed B—for in the First basin all of the coals are of the same general character, and the same statement holds good of other coal basins.

For example, in the First basin the Pittsburgh coal bed is mined near the Maryland line, just west of the Allegheny mountain; but it shows the same character as the coal from bed B, and an average of several analyses shows about 21 per cent. of volatile hydro-carbon to 69 per cent. of fixed carbon.

This feature of similarity of character of all coal beds, large or small, in the same coal basin, is one of interest and importance. It will be dwelt upon in another place in discussing the origin of coal beds and the comparison of anthracite and bituminous coals.

§ 416. The Second, Third and other great coal basins show this same persistency of character of the coal over great areas in any one basin, and the same variation in character between the coals of the different basins.

§ 417. *The persistency of the number of coal beds and the thickness of the interval rocks between them* is strikingly shown in vertical sections of the measures, made in the same basin, but great distances apart; but it is equally true that very nearly the same section is found even after crossing one or more well developed anticlinal axes.

§ 418. To illustrate what has just been said a group of vertical sections of the measures in the First basin has been selected for comparison. These sections were made at various places from the eastern end of the basin in Bradford county, to the southern end of the basin in Somerset county. All of them have been published in detail in this and other reports except one in Clinton county, and the reader is referred to the text of the reports for the details. They are placed on the plate with the easternmost section at the right hand.

No. 1. At the Barclay mines, Bradford county. The First basin is here shallow ; the section only 119′ 3″ long ; reaching only to 50′ above coal B.—See report G, page 125.

No. 2. Compiled from the McIntyre and Red Run sections, Lycoming county. Here the First basin holds all the lower productive coal measures up to the Mahoning sandstone. Section, 359′ 11″ long.—See report GG, page 124.

No. 3. On Little Pine creek, Lycoming county, compiled from several incomplete sections. Here a small area holds all the L. P. coal measures. The measures between beds E and D are badly exhibited in the woods, and probably conceal several small coal beds which ought to be represented. Section, 325′ long.—See report GG, page 93.

No. 4. On the Tangascootac, Clinton county. Section, 236′ 4″ long, made by the writer and still unpublished, as follows :

1.	Hilltop, many pieces of conglomerate sandstone.	
2.	Interval rocks,	20′ 0″
3.	Small crop of black slate and *coal* ?	
4.	Interval rocks, chiefly ferruginous shales, with small pieces of limonite scattered through them,	50′ 0″
5.	*Coal*, the chief bed, worked at Rock Cabin mines,	4′ 0″
	Slate roof, hard and fireclay floor reported.	
6.	Interval rocks, chiefly slate, shales and clay slates,	50′ 0″
7.	*Coal*, the "rolling bed," 4′down to	0′ 4″
8.	Interval rocks, apparently slates,	50′ 0″
9.	*Coal*,	2′ 0″
10.	Massive conglomerate sandstone, measures concealed below,	60′ 0″
	Total,	236′ 4″

No. 5. At Snow Shoe, Centre county. Here the first basin holds all the L. P. coal measures.—*Limestone* (under bed D) here makes its first appearance, going west.—*Iron ore* (230′ below E) at the horizon of the Ferriferous limestone of the Fourth, Fifth, and Sixth basins, here appears. Section, 283′ 3″ long.—See Report H, page 69.

No. 6. At Bennington, Blair county. All the Lower Productive coal measures are here, and the section differs little from that at Snow Shoe.—*Limestone* under D absent ; limestone under E, instead. —*Iron ore* under B absent. Section, 512′ 2″ long.—See Report HH, page 3.

No. 7. At Hooversville, Somerset county. Section, 335′ long.—See Report HHH, page 122.

§ 419. These seven sections from different parts of the First basin will serve sufficiently to illustrate the regularity of the Lower Productive measures in the basin, as well as their irregularity. The full detailed reports from which these sections are quoted, are in volumes H, HH, HHH, G, and the first part of this volume.

The regularity of the interval distances between the different coal beds is very striking; yet from this regularity there are constantly found small variations. While it is true that coal D is usually about 60 feet below coal E, and coal A about 50 feet below coal B, yet the sections show that in some places the interval distances will be 70 feet instead of 50, or 40 feet instead of 60. Within the limits of this variation of say 20 feet in any given interval distance, the regularity of the measures is very great.

This regularity through all the region between the Maryland line and the Snow Shoe mines extends to the whole Lower Productive group, from the Mahoning sandstone down to the Pottsville conglomerate. But in Lycoming and Bradford counties the regularity is only from the Mahoning sandstone down to coal B. Below coal B, in the Little Pine creek basin, the whole distance from B to the top of the Pottsville is only 15 feet; and coal A has almost, if not entirely, disappeared. And in the Ralston-McIntyre basin and in the Barclay basin the measures between coal B and the top of the Pottsville differ widely from each other, and equally widely from the average vertical section of the First basin.

§ 420. *The character of the interval rocks*, and the persistency with which such character is maintained over great areas, is a question of much importance, for rapid and accurate indentification of horizons. In this respect the First basin is unfortunate; the changes in the character of the interval rocks are quick and complete. At McIntyre the whole of the interval rocks between the coal beds, from the Mahoning sandstone to the Pottsville conglomerate, are massive sandstone, with much pebble rock; yet on Little

Pine creek, not more than fifteen miles to the southwest, the separating rocks are almost entirely of soft shales from the Pottsville conglomerate up to coal D. There is really no one sandstone or shale rock in the Lower Productive measures of the First basin, which can be taken and followed far away as a guide to geological horizon.

§ 421. The limestones of the First basin are worse than useless as a guide, and would prove only a delusion and a snare to any one attempting to use them for identification of geological horizon.

In the Barclay basin, the Ralston-McIntyre basin, in the Little Pine creek basin, and on the Tangascootac there is no limestone at all; nor is the horizon of the limestone even occupied by calcareous shales. There is in these localities *no trace at all* of the limestone deposit.

At the Snow Shoe mines in Centre county one small limestone underlying coal D is the only limestone in the Lower Productive coal measures: but there is also a carbonate iron ore, a carbonate of iron and lime, underlying coal B, and in the horizon of the Ferriferous limestone of the western basins.

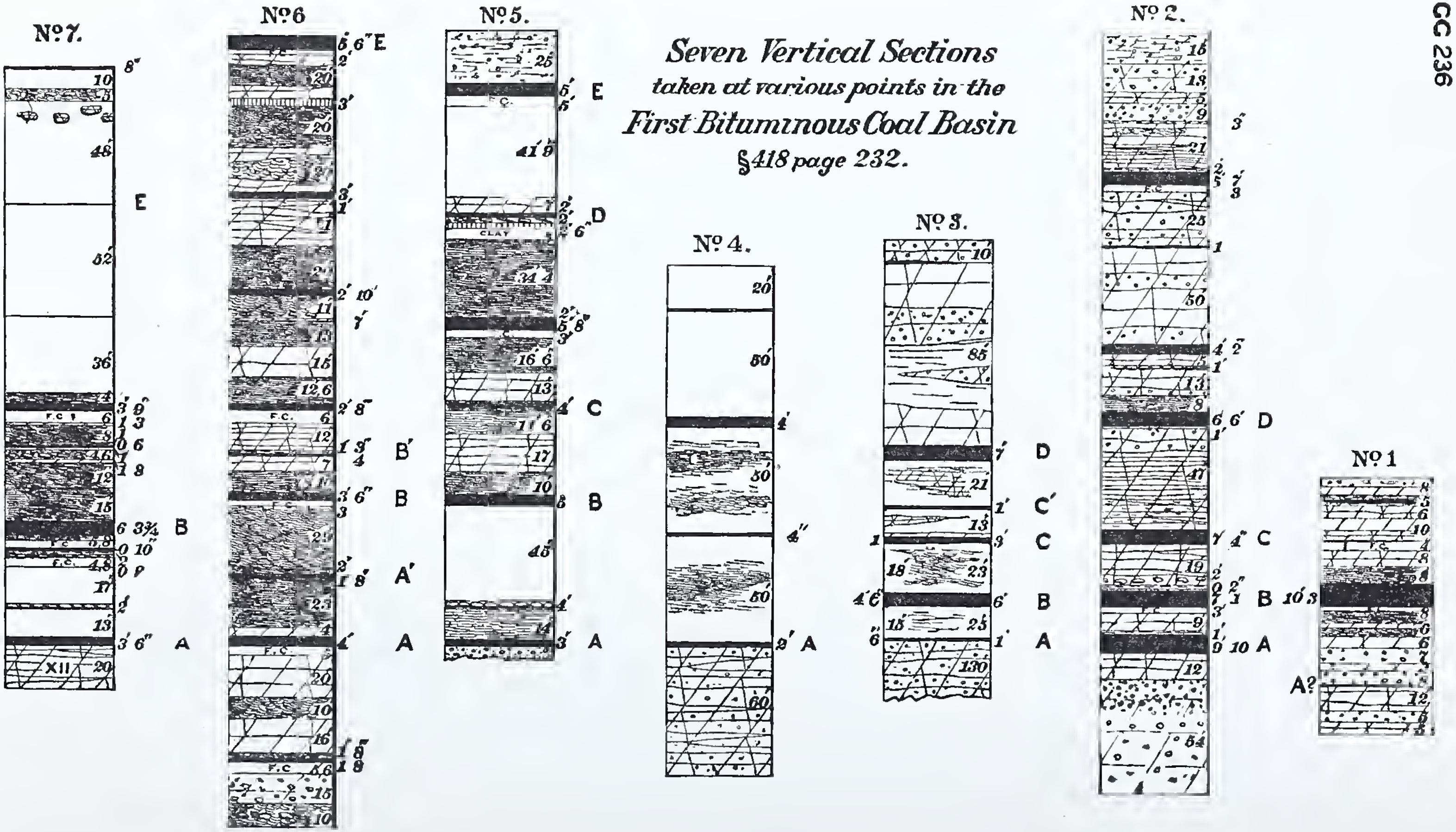
At Bennington in Blair county there is no trace of either the limestone under coal D or the carbonate of iron and lime under coal B. But instead of these there is a limestone under coal E, which limestone was not present at the Snow Shoe.

At Hooversville, Somerset county, none of the limestones are exposed, but the carbonate of iron and lime, 235 feet below coal E, is found in the proper geological horizon of the Ferriferous limestone.

In the Third and Fourth basins as well as those to the west of them, the different limestones furnish the key rocks to the Lower Productive system and are one of the chief guides to identification of geological horizon: but the facts given show that in the First basin the limestones are absolutely valueless as key rocks in identification.

GC 236

Seven Vertical Sections
taken at various points in the
First Bituminous Coal Basin
§418 page 232.



CHAPTER VIII.

Connection between the coking quality and other characteristics of coal.

§422. *The rapid re-absorption of water by a coal*, after having had its water expelled at 225° F., is a question of interest, inasmuch as such re-absorption is so far in every case connected with *non-coking* of the coal. The re-absorption of water is owing to physical structure, and the coking qualities are apparently dependent on the same thing.

§ 423. Prof. Wormley, in his report upon the analyses of coals from Ohio, has noted the characteristic feature of their re-absorbing moisture, when allowed to cool, after being heated to 212° F.

§ 424. Mr. Andrew S. McCreath, in his report* on the analyses of Pennsylvania coals, reports that the Pennsylvania coals have no such characteristics; and that out of many hundreds of coals analysed by him, only a very few so far have possessed the power of re-absorbing moisture rapidly after it has been expelled at 225° F.

§ 425. Under such circumstances it is desirable to note particularly the appearance, behavior, and composition of these peculiar coals.

Three of them are from Sullivan county, one from the New Red Sandstone, in York county, and one from Lycoming county.

No. 1. B. Gross coal, from York county, Pennsylvania, on B. Gross farm, on Liverpool road, three fourths of a mile north of Liverpool, on the Little Conewago creek. Specimen collected by P. Frazer, Jr. The coal is from the Mesozoic rocks.

"The coal has generally a deep black color, with somewhat pitchy appearance. It is very brittle, breaking with *conchoidal fracture*.

---

* Report MM, pages 95 and 96.

Water, at 225°,	4.310
Volatile hydro-carbons,	18.482
Fixed carbon,	74.358
Sulphur,	.528
Ash,	2.322
	100.000

"The coal yields a bulky ash of a reddish brown color. It has not the slightest tendency to form a coherent coke, and yields volatile matters burning with a non-luminous flame. The water was estimated at 225°, and upon withdrawal of the heat the coal begins to absorb water with great avidity; so that in two hours it has re-absorbed sixty-three per cent. of the amount of water originally present."

Throwing out the water, sulphur, and ash, the proportion stands:

Fixed carbon,	80.093
Volatile hydro-carbons,	19.907
	100.000

Volatile hydro-carbons to fixed carbon, as 1 to 4.023.

No. 2. Coal sixty feet below bottom of bed B, at Bernice, Sullivan county, Pennsylvania.

The coal is, for the most part, coated with iron oxide and infiltrated silt. It has a dull dead lustre, and is compact and brittle, with very irregular fracture. The coal does not have the slightest tendency to coke, and yields gases which burn with a *very* feebly luminous flame. After cooling (water estimation) the coal immediately begins to absorb water, and in two hours has re-absorbed about sixty per cent. of the water originally present.

Water,	5.815
Volatile matter,	15.085
Fixed carbon,	62.329
Sulphur,	.474
Ash,	16.297
	100.000
Color of ash,	reddish gray.

Leaving out the accidental impurities, and counting only the ignitible constituents, the proportion stands:

Fixed carbon,	80.514
Volatile hydro-carbons,	19.486
	100.000

Volatile matters to fixed carbon as 1 to 4.132.

It should be noted that this coal specimen was necessarily taken from near the outcrop, which accounts for the oxide of iron coating, the infiltrated silt, and in part for the high percentage of ash.

A second specimen of this same coal, (sixty feet below bed B, at Bernice,) taken from under better cover, was also analysed by Mr. McCreath.

"The coal does not coke, and the gases burn with a *very feebly* luminous flame. The coal, after being dried, begins to absorb water rapidly, and in two hours has re-absorbed sixty per cent. of the water originally present. This amount is not increased by longer exposure.

Water,	4.130
Volatile matter,	15.270
Fixed carbon,	67.362
Sulphur,	.523
Ash,	12.715
Color of ash, reddish gray.	
	100.000

On drying at 225° the coal loses	4.13 %
" " 245° " "	same.
" " 260° " "	4.19 %
" " 340° " "	4.50 %
" " 460° " "	4.69 %
At a dull red heat the coal loses	12.59 %

But in all these experiments the water re-absorbed is about the same; that is, the coal re-absorbs 2.48 parts of water. Irrespective, therefore, of the amount of water, &c., driven off by heat, the portion re-absorbed is practically constant; and this property is not destroyed, even after all the volatile matter is driven off."

No. 3. Coal from opening one and a half miles east of Bernice, Sullivan county, Pennsylvania. Top bench of coal.

"The coal has a dull dead lustre; it is very soft and crumbling, and has a somewhat shaly appearance, with laminated structure. The gases burn with a feebly luminous flame, but the coal does not coke.

Water,	7.930
Volatile matter,	21.410
Fixed carbon,	54.099
Sulphur,	.551
Ash,	16.010
Color of ash, cream.	
	100.000

No. 4. Sullivan county, one mile south of Laporte. From S. Hall's drift.

"The coal has a deep black dull lustre; it is rather friable; contains some slate. It does not show the slightest tendency to form a coherent coke; the volatile matter burns with a *feebly* luminous flame. The coal acts generally in the same way as that from the Bernice lower coal bed.

Water,	6.830
Volatile matter,	21.930
Fixed carbon,	55.413
Sulphur,	.387
Ash,	15.440
Color of ash, red.	
	100.000

Throwing out the sulphur, water, and ash, and counting the ignitible constituents only, these coals show the following proportions:

	Coal No. 3.	Coal No 4.
Fixed carbon,	71.646	71.646
Volatile hydro-carbons,	28.354	28.354
	100.000	100.000

And the proportions of volatile matters and fixed carbon, are for No. 3, as 1 to 2.527; and for No. 4, as 1 to 2.527.

There are several points touching these coals which are noteworthy:

1. They range in proportion of volatile matter to fixed carbon from bituminous to semi-bituminous coals; these proportions being 1 to 4.022; 1 to 4.132; 1 to 2.527; 1 to 2.527; 1 to 4.10.

2. They carry an unusual percentage of water; these percentages being 4.310; 5.815; 7.930; 6.830; 1.510.

3. The gases driven off burn with a non-luminous flame.

4. None of the coals coke.

5. All of the four coals re-absorb in a short time fully 60 per cent. of the water which has been expelled by rais-

ing their temperature to 225° F., in this respect differing from the other Pennsylvania coals hitherto examined.

In the descriptions of the coals given above it will be noted that the gases driven off burn with a *non-luminous flame.* It might be inferred from this that the volatile matter is in fault, being of the same character as that in an anthracite coal, and the coal of course not coking. But Mr. McCreath furnishes the following analyses of coals, which give the usual *smoky, yellow flame,* and have the same peculiarities of high percentage of water, low coking quality, and rapid re-absorbing power. No. 5. *Coal pit bed opening,* 4 miles east of Norwich, corners McKean county. Top bench.

The coal, of a deep black to brownish black color, is generally very compact and brittle, with irregular fracture. It carries numerous thin partings of mineral charcoal, and *yields a coke which is only slightly coherent.*

No. 6. Same coal bed—Lower bench.

The coal has the same general appearance as that from the top bench. It *yields a coke only slightly coherent.*

Both of these coals *re-absorb water rapidly.*

	No. 5.	No. 6.
Water, @ 225°,	5.960	7.710
Volatile matter,	36.385	33.705
Fixed carbon,	51.673	55.868
Sulphur,	.677	.802
Ash,	5.305	1.915
	100.000	100.000
Coke, per cent.,	57.655	58.585
Color of ash,	cream.	cream.
Fuel ratio,	1: 1.42	1 : 1.65

No. 7. Fairmount Coal Co.'s mines, near New Bethlehem, Clarion county. Kittanning middle coal. Luster dull, dead; more or less coated with silt. Brittle; shows but little pyrites. Dried coal re-absorbs water *very rapidly.* Quality of coke, decidedly inferior.

No. 8. T. Murphy's bank. Madison township, Clarion county. Freeport lower coal. Average sample of lot exposed to weather.

Luster dull black; bands of grayish black coal throughout specimens. Compact and brittle, with somewhat cubical fracture. Dried coal re-absorbs water *very rapidly.* Quality of coke, decidedly inferior.

	7.	8.
Water, @ 225°,	4.765	4.775
Volatile matter,	35.675	35.118
Fixed carbon,	54.037	53.632
Sulphur,	.913	1.095
Ash,	4.610	5.380
	100.000	100.000
Coke, inferior, per cent.,	59.560	60.107
Color of ash,	cream.	cream.
Fuel ratio,	1: 1.51	1:1.52

§ 426. Concerning the non-coking properties of these coal Mr. McCreath writes:

"There seems to be a mysterious connection between the coking qualities of a coal and its capacity to absorb water, or in other words, its physical structure. I have gradually come to the conclusion that all coals which absorb water very readily yield inferior cokes. Certain it is that all the coals in which I have noticed this property, either do not coke at all or yield cokes only slightly coherent. I have now observed coals of this character from Sullivan, Lycoming, McKean, Elk, Clarion and York counties. My time has thus far been too much occupied to give the matter the attention it should have in order to arrive at a positive conclusion in the matter; yet the tendency of the whole thing is to point to a relationship such as I have indicated.

I made the following experiments and they are instructive and interesting:

The coals selected were intended to represent the different varieties of coking and non-coking coals.

The results given in the accompanying table were obtained by the following method:

Portions of the coal (two grammes) were carefully dried at 225°, until all the hygroscopic moisture was expelled; they were then exposed for two hours, under exactly the same conditions, and at a temperature of 64°, in a comparatively dry atmosphere. The coals were again weighed and the increase in weight noted.

The results obtained are especially suggestive when we come to compare the *fresh* and *weathered* samples of the same coal.

I have given in the table the amount of water originally present in the coal to show that there is no connection between it and the amount absorbed.

Portions of the coals were coked in a platinum crucible, in the laboratory, and the relative character of the coke was judged from this test.

Table showing a supposed connection between the coking qualities of coals, and their power for absorbing moisture:

	RELATIVE COKING POWER OF DIFFERENT COALS.	Water absorbed by 100 parts dry coal in two hours.	Per cent. water in coal.
1	Quinnimont seam, Virginia, ...	.372	.665
2	Connellsville coal—*fresh*, ...	.399	1.200
3	Richmond gas coal—*fresh*, ...	.419	1.185
4	Cambria Iron Co.'s Miller coal—*fresh*, ...	.522	.745
5	Richmond gas coal, Va.—*weathered*, ...	.572	1.225
6	Connellsville coal—*weathered*, ...	.627	1.170
7	Cambria Iron Co.'s Miller coal—*weathered*, ...	.628	.940
8	Hoagland run coal, Lycoming Co., ...	.807	1.510
9	Fairmount Coal Co.'s Kittanning middle bed, Clarion Co., ...	1.279	5.060
10	Coal pit bed, upper bench, McKean Co., ...	2.030	5.450
11	Murphy's Lower Freeport coal, Clarion Co.—*weathered*, ...	2.438	5.250
12	Coal pit bed, lower bench, McKean Co., ...	2.486	7.050
13	Bernice coal, Sullivan Co.—*non-coking*, ...	2.586	4.130
14	Triassic coal, York Co.—*non-coking*, ...	2.837	4.310

If it can be established that there is a relationship between the non-coking of a coal and its capacity to re-absorb water, it will offer a simple method of testing coking properties which will be of great utility. At present, the chemical composition being no guide at all, it is necessary to actually coke a quantity of any given coal before any opinion at all can be given upon it. If simply testing in a laboratory the re-absorbing power will give general coking properties, it will effect much saving in time and cost.

Chapter IX.

On the presence of anthracite with bituminous coal in the same locality.

§ 427. *The presence of an anthracite coal bed and a semi-bituminous coal bed in the same hillside, and only 60 feet apart,* is sufficiently remarkable to call for special comment. This occurs at Bernice, in Sullivan county, and the semi-bituminous coal underlies the anthracite.

Moreover, in another case, in the same region, a coal bed has two benches, the upper bench semi-bituminous coal, the lower bench an anthracite, with only a six-foot slate parting between these benches.

The discussion of the genesis of anthracite coal is more properly left for the volumes devoted to the anthracite regions, but in view of the peculiarities connected with the small Bernice anthracite basin, it would be as well to state a few points of the case.

Anthracite coal is always regarded as a coke, made under great pressure, and from bituminous coal, by the action of heat. And as the Pennsylvania anthracite coals are plicated in close and steep folds, while the bituminous coals are nearly horizontal, it has been assumed that these foldings have had much to do with the matter.

1. Anthracite coal is not in any way a product of forces which made plications. It is only necessary to cite the case of the Belgian coal fields. The coals there are repeatedly overturned, and are worked deeply at these steep angles, yet the Belgian coals have some 45 per cent. of volatile matters.

2. It has been maintained, and recently, that as none of the anthracite fields are more than 100 miles or thereabouts from outcrops of trap rock, the latter may be assigned as

the cause of all needed heat. For as trap-rock crops out for great distances along the surface on a given line, it may be assumed to go down into and through the rocks as far as the surface-show gives evidence of its doing; that is, if it runs for 100 miles east and west along a crop, it may go through the rocks 100 miles to the north, northeast, and northwest.

But can it be possibly held that a trap rock could supply heat and convert a large coal bed at Bernice into anthracite, and yet not affect a coal bed 60 feet below it?

Or could it be possible that the lower bench of a coal bed could be converted into an anthracite and the upper bench, 6 feet away, be undisturbed?

Or could it alter the rocks of the Bernice basin and never affect at all the Barclay basin, only a few miles away?

Or could it alter the coal layers in anthracite beds and leave the bituminous matter in the slate partings unchanged. This latter is a very striking case. In the fire at the Butler colliery near Pittston, the fire came squarely against a wall of solid coal and went out; but while it could only scorch an inch or so of the coal face, it burned deeply and for long distances into the slate partings between the coal benches.

Why should not that which drove off the hydro-carbons from the coal, do the same thing for the slate.

3. If anthracite coal be a coke, then it follows that it should have more ash than the coal from which it was made.

This is not the case. It is difficult to find, after a careful search, a bituminous coal which runs so low in ash as the anthracite. And if 40 per cent. of hydro-carbons have been expelled to make anthracite, it should have 10 per cent. of ash to 6 of bituminous coal, which it certainly has not.

4. The condition of the sulphur in a coke is essentially different from the condition of the sulphur in the bituminous coal from which that coke was made.

Yet the condition of the sulphur in anthracite coal is similar to the condition of sulphur in other coals.*

---

* Prof. J. P. Kimball states that "Marcasite appears to be the prevailing form of iron pyrites in unaltered or sedimentary rocks, including bituminous coals and lignite, while yellow pyrites or pyrite is the prevailing mode of its occurrence in crystalline and metamorphic rocks, including anthracite."

5. It seems as though the investigation is more likely to run into inquiry of the character of original vegetation and condition while forming coal. For discussion of sphagnous vegetation as the basis of coal, as well as of fireclay floors, see Preface to Report QQ, pp. xviii—xxi.

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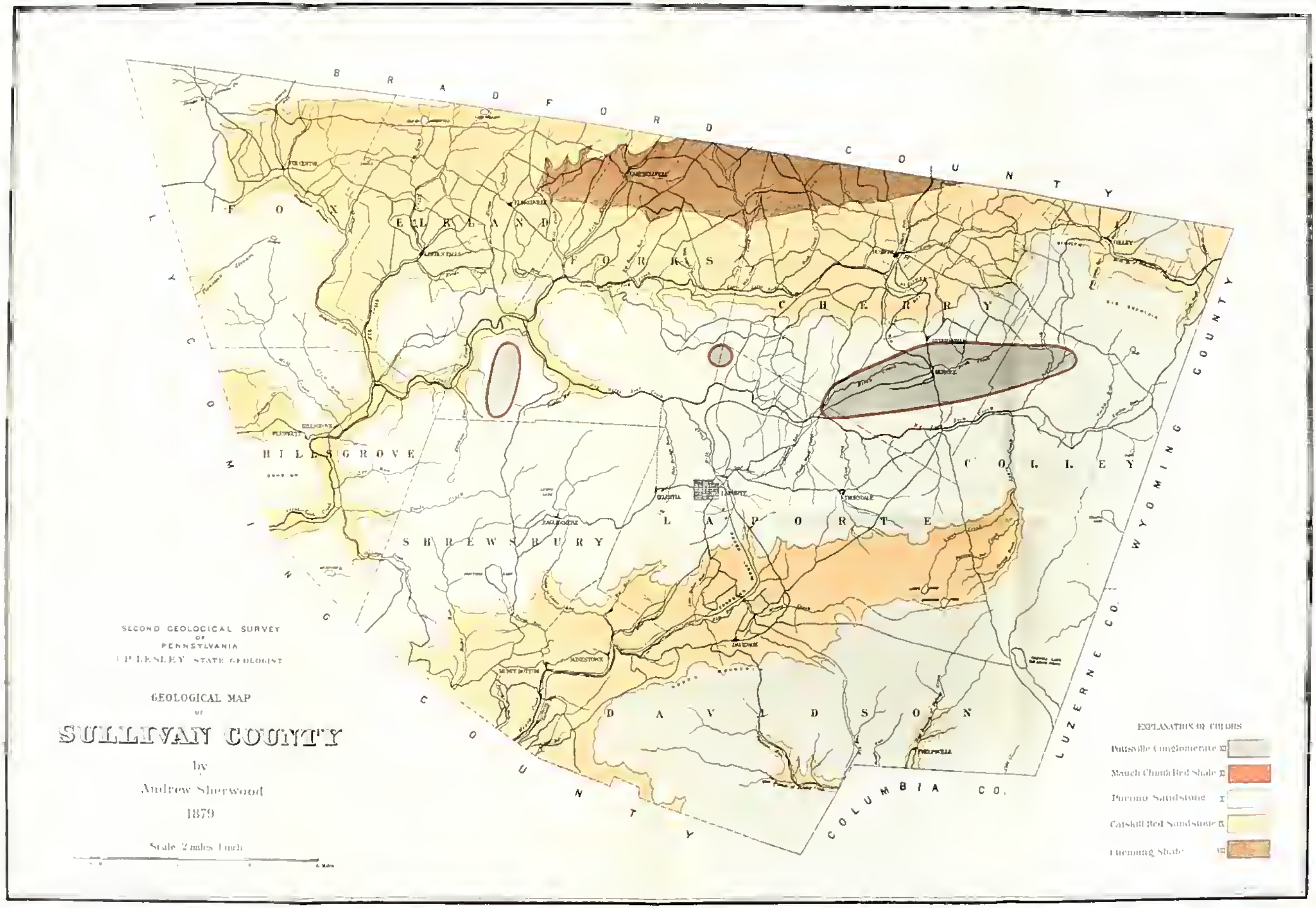

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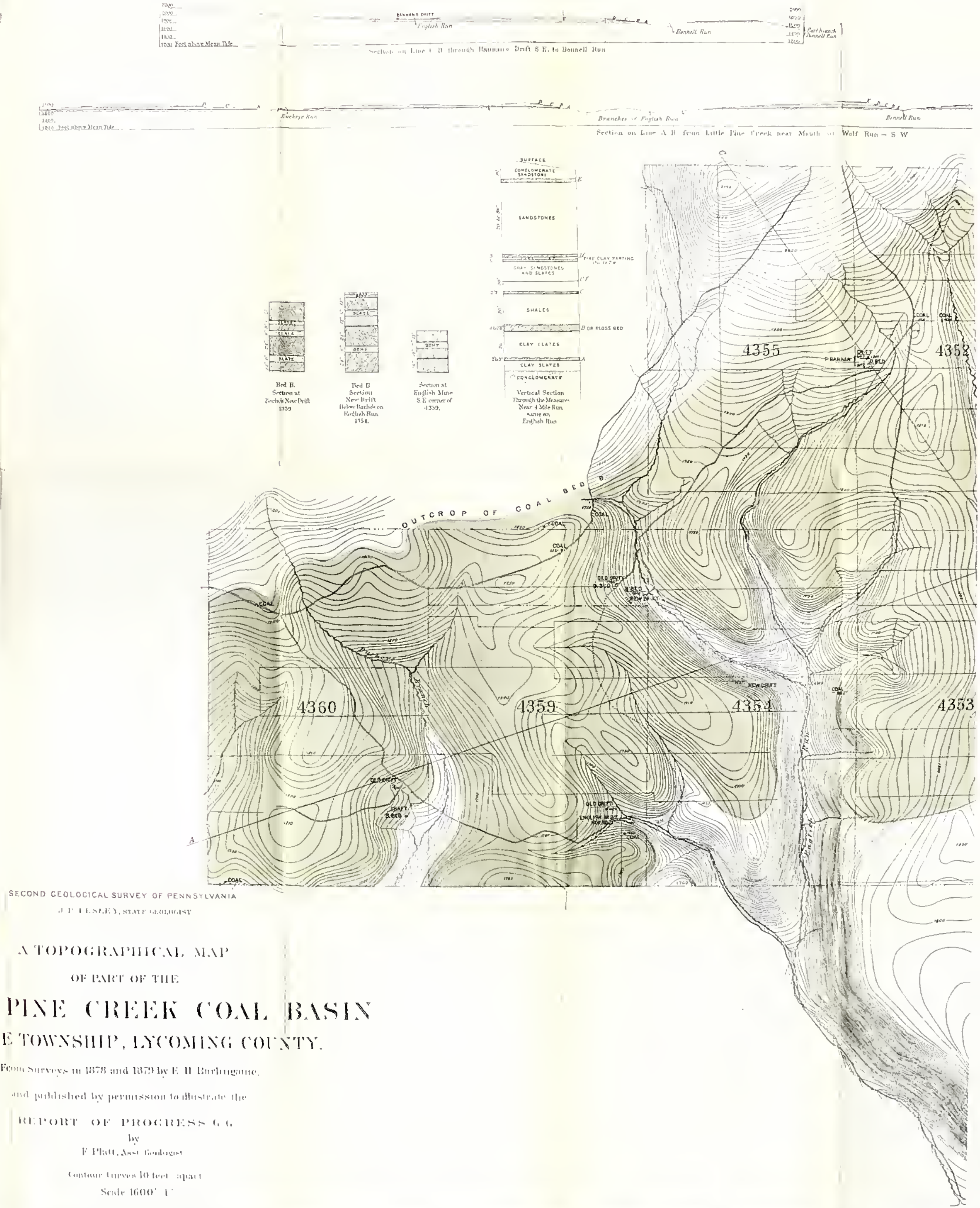
GEOLOGICAL MAP
OF
SULLIVAN COUNTY
by
Andrew Sherwood
1879


Feet above Mean Tide
Bannan's Drift
English Run
Bennell Run
Fork of Branch Bennell Run
Section on Line C D through Bannans Drift S.E. to Bennell Run
Feet above Mean Tide
Buckeye Run
Branches of English Run
Bennell Run
Section on Line A B from Little Pine Creek near Mouth of Wolf Run — S W
SURFACE
CONGLOMERATE SANDSTONE
CONGLOMERATE
SANDSTONES
FIRE CLAY PARTING
GRAY SANDSTONES AND SLATES
SHALES
B OR BLOSS BED
CLAY SLATES
CLAY SLATES
CONGLOMERATE
SLATE
SLATE
SLATE
SLATE
BONY
BONY
Bed B. Section at Bache's New Drift 1359
Bed B Section New Drift Below Bache's on English Run 1354.
Section at English Mine S.E corner of 1359.
Vertical Section Through the Measures Near 4 Mile Run same on English Run
OUTCROP OF COAL BED B
COAL
OLD DRIFT
NEW DRIFT
BANNAN
ENGLISH MINE
4355
4352
4360
4359
4354
4353
A
C

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA

J. P. LESLEY, STATE GEOLOGIST

A TOPOGRAPHICAL MAP
OF PART OF THE
LITTLE PINE CREEK COAL BASIN
IN PINE TOWNSHIP, LYCOMING COUNTY.

From Surveys in 1878 and 1879 by E. H. Burlingame,

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REPORT OF PROGRESS G G
by
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Contour Curves 10 feet apart
Scale 1600' 1"

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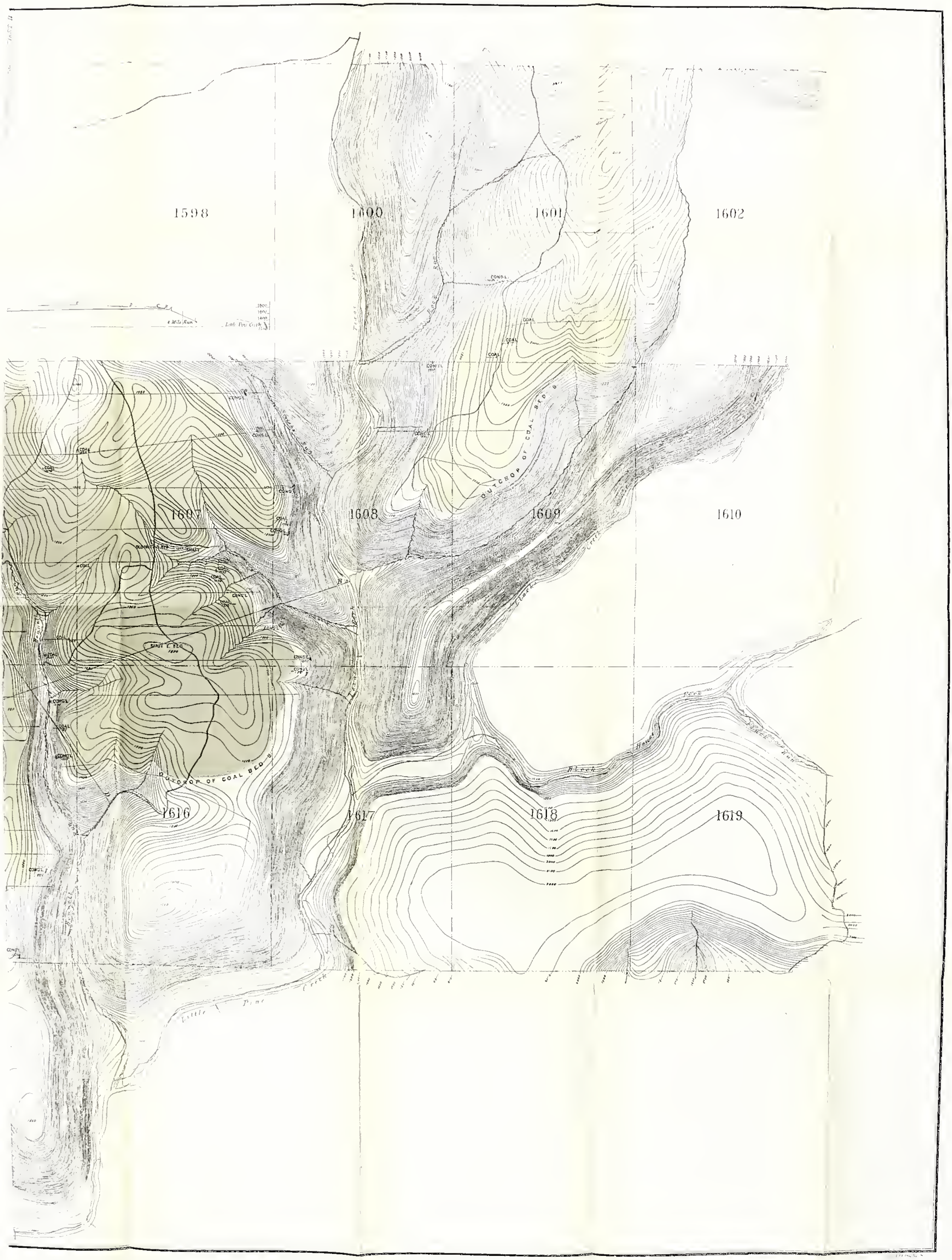

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